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THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY.

Publishing Office, No. 42 Pine Street.

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME XXVI.—No. 10.
Whole No. 430

NEW YORK, WEDNESDAY, MAY 16, 1877

$3 PER ANNUM IN ADVANCE.

A. M. CALLENDER & CO., Proprietors.
G. WARREN DRESSER, Editor,

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☞ An asterisk (*) denotes an illustrated article

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WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

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THE LONDON TREATISE ON THE MANUFACTURE OF COAL GAS.

This work is now being issued in monthly numbers, and will be one of the most valuable compendiums of information bearing upon the history and the science and practice of gas manufacture yet published. Every gas manager should have it. It is issued in paper covers, so that it can be bound to suit the taste of the subscriber. The issue will occupy about two years. The price of each number, if furnished from this office, is 40 cents a number, or $4.80 a year.

We have already received many subscriptions, and we would urge all those who have not yet sent us their names to do so at once. We propose to send bills for the first 12 numbers upon receipt of subscription.

OPPOSITION GAS WORKS.

The whole matter of opposition companies is most curious when their history is followed out, and if City Councils would take a little pains to inform themselves as to what has been done in the past, both in this country and England, it would seem as though a better judgement could be arrived at. In London, a few years ago, a dozen or more companies were supplying the city with gas. Opposition had full sway, but it did not last; the most of them have now consolidated, and the question now is whether to have two companies, one on each side of the river, or whether it would be better to have a single one. The business incident to the manufacture of illuminating gas is not the same as that of a grocer or provision dealer. The article sold could not be well taken home in a bundle or a jug, from the dealer; neither has experience shown that it is economical, and perfectly safe for every one to manufacture their own gas in large communities.

A large outlay of money is required for proper apparatus, and the wear and tear is such that works have to be practically rebuilt about once in 10 or 15 years. Skilled men are required to conduct the operations incident to the manufacture, and everything about the business is of such a nature as to lead to the inevitable result, that the larger the amount made, the smaller the cost.

There might be some question as to the limit to which it would be desirable to extend a single works; but there can be but little doubt but that two or more works, under a single management, can be much better and more economically conducted, than the same number of independent and separate works could be, each under its own separate organization of presidents, directors, and officers.

This is shown very clearly by the statistics which we published last year (p. 132, vol. xxv.) of the workings of the German Continental Company, which, under one central management, operates 18 gas works in sixteen different cities. The table shows that as the amount made increased, the price went down and the dividends went up. If city councils would give any guaranty as to the basis upon which the city portion of the business would be conducted, for any definite length of time, they would secure the public lighting at much lower rates, on the same principle that a long loan, on good security is obtained at a lower rate of interest than a short one.

There is another point in connection with opposition companies that should be born in mind. After the competition has ceased, which generally happens, (one party or the other finding it impossible to pay dividends) some arrangement is entered into between the two companies. The object of this is a matter of business, and the compromise is usually accepted by one or the other party as a matter of self preservation, and often a large consideration, either in cash or stock and bonds, is paid by the worsted party, simply for the consideration of being allowed to make a living. The successful company, which is generally the older one, is not responsible for the existence of the other. That is usually one of the blessings conferred by the City Fathers for the benefit of the dear people; but, having come into existence, and paid for the privilege of continuing, it would certainly have very just cause of complaint if the other company were to continue to sell its product at a competing price that would still entail financial ruin upon its neighbor—although, owing to smaller capital or larger business, it might be able to do so.

The true interests of every community would be served not by multiplying organizations or increasing the number of companies within itself, but by granting such liberal privileges, etc., to companies all ready formed as would enable the authorities to reasonably require a faithful service for a fair compensation, and enable the company to reduce the price by means of the decreased proportionate cost resulting from a larger manufacture. The argument *now* generally used is that some new method has been invented by which a new company will be able to make gas so much cheaper as to entirely break up the old company. Time alone will show whether this argument succeeds any better than the old one. In many instances, we fear, it will prove to be "a good

enough Morgan to divide upon," and the claims for cheapness in first cost will either prove to be mistaken ones or else some accompanying disadvantage will more than offset the difference.

We have heard during the past year many very grand accounts of the established success of a new process in a neighboring city, and, on the strength of this, several new works are being started to work under the same process; but, before they are completed, rumors fill the air that the great paternal works, where the great new thing burst forth in all the splendor of a Centennial Jubilee, are not doing as much as they were, and, in fact, notwithstanding the enormous profits resulting from the use of the new process, a coal gas works on the largest scale, with forty-eight inch connections, etc., etc., and covering 18 acres of ground, are being pushed to completion by the very company who had the full benefit of the use and intimate knowledge of this new invention. In fact cruel Rumor whispers, in tones quite distinct, that the district supplied by the new born process is complaining and wants no more of it, and that ere long its functions, in that locality, will cease.

THE INDIANAPOLIS GAS QUESTION.

The new company in their endeavors to secure a reduction of their bond, compelling them to remain forever an "opposition" company, seem to have met with considerable opposition in the City Council; but at a meeting held on April 23d, a resolution was passed reducing the bond from $100,000 to $25,000. This is quite a come down on the part of the city, and would indicate the value that the western city fathers place upon a "lively competition." On the other hand as the city increases in size and population, and the new company has expended a large sum of money in preparing to do business upon the basis of small profits with, perhaps, a large capital and bonded indebtedness, it may become apparent to some future manager of the now new company that more money could be made by putting in $25,000 more into the debt, and forfeiting the bond—pay that $25,000 to the city therefor, and then go into an arrangement with the old company, divide districts, put up the price, and do, as many others of this kind have done before, "live in peace and harmony with their neighbors" and be able to pay a dividend.

☞ THE REPORT OF THE PROCEEDINGS of the American Gas Light Association for the Washington meeting, and the last two annual meetings in New York is to be published by the Association, in book form bound in cloth. The work is to be done by The Case Lockwood and Brainard Company, of Hartford, Connecticut.

Mr. Vernon Harcourt on Sulphur Purification.

Sir: I have just read with astonishment Mr. Harcort's statement respecting gas purification, in his lecture published in your journal of to-day, viz., that sulphide of sodium and sulphide of ammonium are alike incapable of absorbing the bisulphide of carbon (or, to use the parliamentary phrase, the "sulphur in other forms than sulphuretted hydrogen") from coal gas. But when reading the mode of experiment adopted by Mr. Harcourt for trying the effect of these materials, my astonishment ceased—or rather, it assumed a new form; I ceased to be surprised at the results which he obtained, but was filled with astonishment that any one conversant with gas purification, stil more an eminent chemist, should have conducted such experiments in such a manner.

Mr. Harcourt has a model washer for ammonia, in which the gas is purified from ammonia by passing the crude gas *over the surface* of the water. Whether this washer removes the last traces of ammonia, Mr. Harcourt has not ascertained, but he believes it is capable of doing so, and probably this may be the case. Now, this effect of water upon ammonia has been not only known, but applied in gas works for many years. To take one instance, well known to every gas engineer in London, the "Livesey scrubber" (not the greatly superior and admirably perfect washer which Mr. Livesey has recently invented) is constructed precisely on this principle of passing the gas, not through water, but over an extensive watery surface; and four or five of these scrubbers have been in successful use for many years at the South Metropolitan Gas Works. But what suffices for ammonia does not necessarily, or even naturally, suffice for the sulphur purification. The affinity of ammonia for water is extraordinary, whereas Dr. Odling, and every one who has properly experimented with the bisulphide of carbon, have recognized and stated the fact that this kind of gas impurity can only be absorbed from gas slowly, or by prolonged contact with the purifying materials employed. But even to take the case of impurities, which are easily and rapidly absorbed in the purifying processes, would any gas engineer (or, one would have thought, any chemist) ever dream of purifying gas from H_2S, by merely passing it *over the surface* of oxide of iron, or of extracting the CO_2 by passing the gas *over the surface* of lime? Or, to come to the bisulphide of carbon, Mr. Harcourt finds (as I was the first to show, five years ago), that when the gas has previously been properly prepared, especially by the elimina tion of the CO the bisulphide of carbon will be *thoroughly* extracte by passing the gas through sulphide of calcium. But certainly I never imagined that this absorption would take place if the gas were merely passed over the surface of sulphide of calcium. And if Mr. Harcourt tries sulphide of calcium in the same manner as he has chosen to try the two other alkaline sulphides (viz., of sodium and ammonium), by merely passing the gas *over the surface* of the purifying material—and if he chooses, as he has done relative to the two other alkaline sulphides, to give the results of his experiments authoritatively to the gas world—he will have to astonish gas managers anew, and in the teeth of five years experience to the contrary, by declaring that sulphide of calcium is totally inefficient for extracting the "sulphur" from gas.

Let Mr. Harcourt pass the gas through these two liquid alkaline sulphides, and then he will find that they do absorb the "sulphur," and that most efficiently. In the beginning of 1872 I made dozens of experiments with the sulphide of sodium and ammonium, and I found them quite as efficient as the sulphide of calcium. I used these solutions in a small tin scrubber, about four feet high, filled sometimes with coke and sometimes with pumice, through which the gas, as supplied to the public, was passed, after being freed from its CO_2. The analyses of the gas so purified were made by Mr. W. H. Thompson, the Chemical Assistant of the Referees, whose ability, carefulness, and integrity are a sufficient guarantee to all who know him for the correctness of the results. These analyses, with the conditions of my experiments, were regularly entered by him in his note book, which, since his premature and lamented death in 1874, I have been unable to recover. But I have still some loose MSS. pages, in which I entered, at the time, the results of some of the earliest of those experiments—those which naturally interested me at the time. From this contemporaneous MSS. I extract the following experiments, the analyses, as I have already said, being made by Mr. Thompson—

Sulphide of Sodium in Coke Scrubber.

		Sulphur remaining in gas.			
Experiment	1 (imperfect)	7.8	grains	per	100 ft.
"	2	5·08	"	"	"
"	3	4·2	"	"	"
"	4	5·47	"	"	"
"	5	3·8	"	"	"
"	6	4·23	"	"	"

With Double Scrubber.

Experiment	1	4·8	"	"	"
"	2	5·4	"	"	"

I remember that in one of these experiments with sulphide of sodium, the gas so purified contained only a *fraction of a grain of sulphur.* Mr. Harcourt, in his lecture, states that he believes the "sulphur" can be *wholly* extracted by sulphide of calcium, as employed by the process which I made public in 1872—a statement which accords with the results which I obtained five years ago; and I venture to repeat that equally good results can be obtained either from the sulphide of sodium or the sulphide of ammonium.

But I carried my investigations of the action of soda and ammonia upon the sulphur impurity much further than this—indeed, into ground which, certainly so far as public knowledge is concerned, is even now a *res nova.* In my patent of March, 1872, I attacked the sulphur impurity systematically, and at every practicable point, as indeed is evidenced by the fact that, although no less than £3,000 has been spent by the Referees in experiments to discover some other means of extracting the sulphur, no other such means have been discovered.

One of the several processes deliberately planned and tried by me in 1872 was the employment of soda and ammonia in their simple state of caustic alkaline solutions; my object in doing so being to act upon the bisulphide of carbon through its acid or acidulous character, but always applying my new principle of previously preparing the gas, by the extraction of the other elements, CO_2 and H_2S, which would combine with these materials, and destroy their alkaline action on the bisulphide of carbon. In my contemporaneous memoranda I find the following experiments—

Soda in Coke Scrubbers.
(No lumps on top.)

Experiment	1.	Sulphur left in gas..	14·65	grains.	
"	2.	" " " ..	16·9	"	
"	3.	" " " ..	18·8	"	

Soda in Pumice Scrubber.
(Lumps on top.)

Experiment	1.	Sulphur left in gas...	20·1	grains.	
"	2.	" " " ...	20·9	"	
"	3.	" " " ...	21·13	"	

Ammonia (Half Strength) in Coke Scrubber.

Experiment 1. Sulphur left in gas... 12·5 grains.

These experiments (and I made several others) show that, provided the gas be previously *prepared*, in the manner which I was then the first to make public, the action of simple caustic alkalies *in solution* is capable of reducing the "sulphur," steadily and reliably, to about one-half its ordinary quantity. This was really a good result to be obtained at that time, and by a cheap and simple process; and if this method is now (very rightly) disregarded, it is only because I simultaneously made public processes which were perfect, and entirely efficient for the same purpose. One point in connection with the action

of these simple alkaline solutions in absorbing the bisulphide of carbon (provided the gas be previously suitably prepared by the extraction of the CO_2 and H_2S) is worthy of notice—namely, the new proof thereby given of the well-known chemical fact, that substances act more efficiently in the liquid than in the solid form; because, as is well known, fresh or caustic lime, an equally potent alkali, yet which, owing to its being but slightly soluble, is most efficiently employed as a solid, is incapable of extracting the bisulphide of carbon from gas. This superior action of *solutions* over *solids* is pointed out at considerable length by Dr. Frankland, in his essay, in the latest edition of "Clegg," the passage ending with a quotation and adoption of one of the oldest chemical *dicta* in existence—"*Corpora non agunt nisi sint soluta.*"

At the time I made my invention, no method had been revised for revivifying gas liquor without a serious loss of the valuable ammonia, owing to its extreme volatility; and hence I gave my attention to soda (which is non-volatile) as well as to ammonia. But now that Mr. Hills, by an improvement of his apparatus (which I am surprised is not in general use in gas-works,) has successfully accomplished this most valuable object, a solution of caustic ammonia will, of course, be preferred to the use of soda; in fact, as I can state, on the authority of Mr. G. Livesay, caustic ammonia (in the form of gas liquor revivified by Mr. Hills's apparatus) can now be obtained at *one-half the cost of lime*, besides the *saving of labor*, by employing washers or scrubbers in lieu of purifiers, which require constant filling and emptying.

In addition to all this is the fact that, by using alkaline solutions, whether of soda or of ammonia, according to my process (now well known), the gas can be entirely purified from begining to end *in closed vessels*, which occasion no nuisance; and purifiers can be (and even upon economical grounds I make bold to say ere long will be) wholly dispensed with. All this is to be found stated expressly in the specification of my patent five years ago. * * *

R. H. Patterson.

22, *Wingate Road, Hammersmith, April* 17, 1877.

The Sanitary Conditions of City Houses.

Human ingenuity has been able as yet to devise no system for the disposal of all manner of liquid waste which is at once so inoffensive, so invisible, and so healthful as a well-arranged system of water-carriage removal. The unfortunate thing about it all is that it is easy to meet the requirements of the fastidious by such a development of the system as is from a sanitary point of view the worst possible. Marble-top wash-stands with silver-plated fittings, decorated china closet-bowls, planished copper baths set in cabinet work of hard wood, stationary trays in the laundry, and the brightest and handsomest workmanship wherever the plumbing is visible throughout the house, are too often, indeed it is hardly extravagant to say almost universally, the outward manifestation of the most pestilential hidden dangers. Art can hardly achieve more in the way of luxurious appointments than is compassed by all of these details in a modern house of the best sort. The character of the finish has much to do with the estimate that the intending purchaser or tenant puts upon the house he examines, and they are the subject of some of the most minute of the architect's specifications. When we consider the interior construction and arrangement of the hidden system to which they belong, we approach a part of the subject concerning which the purchaser, the architect, and the tenant are too often ignorant and indifferent. Nor do the dangers which belong to the modern house drainage system cease when we pass the limit of private work, and come to the public sewer to and from which the house drains lead.

The sewer and the drain meet one imperative requirement of the community. They are hidden from sight, and their processes are not offensively manifest, as are those of the slush bearing surface gutter. It is often assumed, perhaps because of the name given to the air of which we hear so much and which is so widely destructive "sewer gas," that we have only to improve the character of this or so to detach our private system of drainage from it as to prevent the transmission of its air.

It is probably true that no city of its age can rival New York in the defective condition of its brick sewers. They are too often badly planned, badly built, and badly kept, and they do unquestionably produce a vast amount of sickness and death. We can by no means, however, charge them alone with all or nearly all of the harm that is done; for so far as the production of dangerous gas is concerned, the waste-pipe of the house itself, smeared from top to bottom with the foulest organic matter putrefying under the worst conditions, and with frequent variations of temperature caused by the entrance of hot and cold water, is at least a brave rival of the worst street sewer.

The lack of ventilation of even the best sewers of New York and of American cities generally makes it important that we shut off as completely as possible the communications between the air that they contain and the air of our soil-pipes. Were these sewers well made and properly ventilated, the suggestions about to be offered concerning the soil-pipe might be materially modified; but circumstanced as we are with reference to the public sewer, we must arrange to use it only as a means for getting rid of our liquid outflow, and must provide for our security against injury from its poisonous gases by a proper construction of our own *cloaca minima;* that is to say, we must have no more to do with the public sewer than is absolutely necessary, treat it as a deleterious outside influence against which we must adopt safeguards.

There are still very many houses in all our cities in which lead soil-pipes are used. The experiments of Dr. Fergus of Glasgow have demonstrated in the clearest way the great susceptibility of lead to the corroding influences of the foul gases arising from organic decomposition. He cites a great number of instances in which even after a few months' use the action of these gases upon the material of the soil pipe has perforated it through and through, and in some cases completely honeycombed a considerable area of its wall. This effect is produced by gases and not by the foul water, as is proven by the fact that the perforations are always at the upper side of the pipe, and never on its lower side where the water flows. It occurs along the upper side of horizontal and oblique pipes, and especially at the upper side of a bend as in front of a trap, for the reason that the lightness of the gas causes it to lie chiefly against these parts of the pipe. The perforations being at the upper side of the pipe, they are not manifest by the leaking out of water as the conduit is rarely filled. Often where it is horizontal or oblique it serves only as a gutter, its upper side being largely eaten away.

Even the smallest perforation may become a source of the most serious danger; a mere pinhole may permit the escape of such an amount of air from the pipe as to poison the atmosphere of a large room. The apertures formed by corrosion, however, are rarely so small as pin-holes, and they are not infrequently large enough to admit the finger.

In modern practice it is almost universal to use for the soil-pipe and the larger branch-wastes, cast iron in the place of lead. This material is not susceptible of perforation from the action of its contained gases; but as the drainage works are constructed, it is often fed by numerous waste-pipes made of lead, which come to it from bath-tubs, wash-basins, butler's sinks, laundry-trays, and urinals, and even the water-closet usually has a trap or a connection-pipe made of lead. All of these leaden connections are subject to the same liability to corrosion as is the lead soil-pipe itself; and in one sense they aggravate the danger, from the fact that perforations occurring in them are more likely to discharge gas into sleeping rooms or into the more frequented parts of the house.

The especial adaption of lead to the construction of these minor waste-water channels because of its flexibility, and the ease with which it is jointed, make it almost necessary that it should be used; but, as plumbing-work is generally constructed, it is used with more or less risk of danger.

The old soil-pipe was invariably a tight one, and was generally separated from the connection with the sewer by a trap. The air it contained was not only extremely foul, but it was subject to expansion on the addition of warm water and from the production within it of the gases of decomposition. This expansion *must* be relieved; and it invariably is relieved under such circumstances, by the forcing of that one of its traps which has the least head of water to be overcome. The air in a street sewer is generally subject to more or less expansion from the same source, and to compression by the entrance of large volumes of storm water, and by the blowing of strong winds against its outlet. The pressure in this case finds its relief by forcing the weakest house-drain trap, and the weakest trap between that house-drain and the interior of the house.

It has for some time been usual in all complete plumbing-work to relieve the soil-pipe by carrying a small "stench-pipe" from its upper part, out through the roof of the house. This is generally a pipe of not more than 1½ or 2 inches in diameter; and in order to protect it against the admission of rubbish from above, it is either domed over, and perforated with a number of small holes, or its upper end is bent so that its outlet shall be turned downward. Where this pipe is not so long and crooked as to offer considerable resistance by friction, and where the perforations at the top are sufficiently large and numerous, it serves a good purpose in relieving the pressure of expansion. Under quite unfavorable circumstances it will still, probably, be easier for the pressure to relieve itself through this stench-pipe, than through any water-trap; and in so far as the danger comes from this cause, it is an effective device.

The more recent investigations into the nature of sewer-gas have demonstrated that in its poisonous condition it is the product of on obstructed decomposition; of fermentation, which Pasteur aptly calls "life without air." The atmosphere within the soil-pipe does not contain sufficient oxygen to supply the continuous decomposition, which is thus checked until the oxygen which it requires is supplied by the constituents of the organic matters themselves—a process which leads to a radical difference in the resultant gases. Instead of being a thorough destructive oxidation of the material, it becomes a putrefying decomposition, producing foul-smelling and dangerous results.

That part of the soil-pipe which carries the waste of the butler's pantry and the kitchen-sink is more or less charged with melted grease, which coats particles of food and of filth, and so shelters them from the action of the air, giving the same pernicious character to their decomposition.—*The American Architect and Building News.*

Report of the Department of Public Works for the Quarter Ending December 31 1876, Bureau of Lamps and Gas.

DEPARTMENT OF PUBLIC WORKS,
BUREAU OF LAMPS AND GAS,
NEW YORK, January 4, 1877.

Hon. Allan Campbell, Commissioner of Public Works:

[Continued from page 199.]

The Manhattan gas company was the only company affected by the above resolution, inasmuch as the other companies mentioned therein had no contracts with the city, the same having expired some years previous. On December 31, 1864, the day following the approval of the resolution by the Mayor, the Manhattan company gave the Street Commissioner the required written notice to the effect that they desired to terminate the contract then existing between the city and said company, and that they would hold the said contract was "absolutely at an end at the expiration of ten days after the receipt of this notice."

A new agreement and specifications were then prepared for lighting all the public lamps throughout the city for the term of one year, and proposals were invited in the official papers to be received by the street commissioner, on January 18, 1865. The proposals were received, but in consequence of the absence of the then Comptroller, the same were not opened, and, hence, new contracts were not made.

On January 26, 1865, the Manhattan company gave the Street Commissioner written notice that for all lamps lighted, and to be lighted after the tenth day of January of that year, the company would claim and require to be paid at the rate of $53 per annum for each lamp. The New York, Metropolitan and Harlem companies had given similar notice in the previous year. All the companies then regularly presented bills to the department, in which they demanded greatly increased rates, averaging about $53 per annum. These claims, however, were not recognized by the department, and the bills remained unpaid for the whole of the year 1865 and part of 1866. The Harlem gas company, early in the year 1865, had commenced an action against the Corporation in the Superior Court of this city, and judgment was obtained in their favor. An appeal was then made to the Court of Appeals, where the judgment was unanimously affirmed, with costs. Further litigation being then prevented, all the companies were paid the amount of their claims, and then they continued to charge at the rate of $53 up to January, 1872, when the then commissioner of public works notified them that their prices must be reduced. In consequence of this notice more favorable rates were obtained by the city, and the companies continued to light the lamps without contracts until January 1, 1874, on which date the first contracts under the present charter went into effect—the contracts having been made for the full term of the year 1874.

The next grant or franchise issued was given to the Harlem gas-light company, in April, 1855, (Exhibit "H"), and covers all that portion of the city lying north of the centre line of 79th street. This grant appears to be a perpetual one, as no time is fixed for its expiration. In the third article, it will be seen that the "Mayor. Aldermen and Commonalty reserve the right to purchase at any time from the said company all the material, pipes, fixtures, buildings, and all the personal and real property owned by said company, by paying to the said company the cost of the same and ten per cent. over and above said cost."

The next grant was given to the Metropolitan gas-light company, in December, 1858, (Exhibit "I"), for the term of thirty years, and covers the whole city. This company commenced operations by furnishing gas to that portion of the city lying between 34th street on the south and 79th street on the north, and, hence, entered into competition with the Manhattan gas company. In a short time, however, the competition was brought to a close by the purchase from the Manhattan company of all the pipes which said company had laid in the district above-mentioned; since when neither company have laid mains in or interfered with the district of the other.

The grant next in order was given to the "Anthracite gas-lighting and heating company," in September, 1863, (Exhibit "J"), and was for a period of fifty years, covering the whole city. On May 26, 1875, this grant was amended by the Common Council by adding the words, "and their assigns." The grant was then assigned to the Citizens' Mutual gas light company, which, in turn assigned the same to the Union gas light company (incorporated by chapter 944, Laws of 1871). This company, having become insolvent, was sold out by a receiver, and the property and privileges held by it were purchased by a Mr. Clarke Bell, who subsequently assigned the same to the Knickerbocker gas light company, which company now holds possession of the franchise.

The grant next in order was given to the City gas company of New York, in June, 1865, (Exhibit "K") for the period of fifty years, and covers the whole of the city. Of this company, and who compose it, I have no knowledge and presume it to be extinct.

The next grant was given to the New York Mutual gas light company (Exhibit "L"), a company incorporated by an Act of the Legislature passed April 17, 1866. The term is for thirty years and the franchise covers the whole city. This company commenced the manufacture and distribution of illuminating gas in the year 1872, and now have over ninety miles of mains laid in various streets, between Wall st. on the south and Sixty-fifth street on the north It is lighting thirty-five hundred and thirty-seven street lamps and has thirteen thousand private consumers. This company enters into competition with the New York, Manhattan, Metropolitan, and Municipal Gas Companies.

There is also a company organized under an act entitled "An act to authorize the formation of Gas-light Companies," passed February 16, 1848. It is styled the Municipal gas light company of New York, but it has no franchise from the city authorizing the laying of gas mains. Their works are situated on Forty-fifth street, near the North River, and were formerly owned by the Oxygen gas light company (which I believe is defunct). It has nearly four miles of mains which were laid by the Oxygen gas light company under a permit given by the then commissioner of public works, in November, 1871. This company manufactures its gas by a new process from water and naphtha, called "water gas."

There is also a company organized under the General Law, styled the "Knickerbocker gas light company," which is the successor to all the rights and privileges of the Anthracite gas company and the Union gas light company. It has laid nearly 11 miles of mains during the past year; but as the company has no works situated on the line of or near said mains, I presume that the pipes were laid under their franchise, for the use of the Municipal company, inasmuch as these mains appear to be a continuation of the mains of the latter company. The Knickerbocker gas company own complete works at 96th street, East river, which were erected by the Union gas light company, but have no mains laid in that section of the city. With the Municipal and Knickerbocker companies in active working operation, the Corporation will have the benefit of the competition between the former company and the older companies in their section of the city, and of the competition between the latter company and the Harlem company in that part of the island north of 79th street.

Chapter 944, Laws of 1872, gave to certain persons mentioned therein the right to lay pipes in all the streets, avenues, and places in the City of New York, lying north of the centre line of 79th street, including the Central Park in all its parts. Under this act the Union gas light company was organized, and its rights and privileges, as before stated, are merged in the Knickerbocker gas company.

There are also grants from the towns of Morrisania and West Farms (Exhibits "M" and "N"), to Messrs. Robert Campbell & Co., authorizing the laying of gas mains, etc., in the respective towns for the term of 20 years. These grants were subsequently assigned to the Westchester County gas light company (Exhibit "O"), which, in turn, assigned the grant from the town of West Farms to the Suburban gas light company (Exhibit "P"). There is also a contract dated December 23, 1870, between the Board of Trustees of the town of Morrisania (now 23d Ward), and the Westchester County gas light company, for furnishing the gas for and lighting the public lamps in said town for the term of ten years, from the 1st of January, 1871 (Exhibit "Q"). At a special term of the Supreme Court, held in the City and County of New York, on the first Monday of April, A. D. 1875, Hon. Geo. C. Barrett, Justice, it was ordered that the Westchester County gas light company "be and is hereby authorized to assume the name of the Central gas light company of New York City, from and after the 15th of May, 1875." There is also a contract dated November 5, 1870, between the Board of Town Officers of the town of West Farms (now 24th Ward) and the Suburban gas light company, for the term of ten years, from the first day of January, 1871 (Exhibit "R".)

By chapter 613, Laws of 1873, being the act entitled "An act to provide for the annexation of the towns of Morrisiana, West Farms and Kingsbridge, in the County of Westchester, to the City and County of New York," the two contracts above mentioned became a charge upon this city, and the public lamps came under the supervision of this department on January 1, 1874.

The prices fixed in these contracts for the ensuing four years, appear to me to be exceedingly high, and beyond all reason, considering the present and late depreciation in values, and the city will, doubtless, be compelled to pay for the lamps in these two wards, during the continuance of the contracts at the ruling rates of 1870 and 1871, when the prices of labor and materials were inflated to an enormous extent. This is an evidence of the lack of foresight in the authorities of any city or town in binding their municipalities for such a length of time, and in all places where it has been done, I believe the taxpayers have had just reason to regret it. If the contracts with the two above mentioned companies had been made for a term of five years, instead of ten, new arrangements could have been concluded wherein a large annual saving would be effected in the expenditures of this bureau.

In addition to the franchises now in existence, the following action has just been taken by the Common Council, viz.:

Resolved, That permission be and is hereby granted to all incorporated gas light companies to lay gas mains and pipes in the streets, avenues, and public places in this city for the purpose of supplying gas to this city and its inhabitants, upon such conditions as may be prescribed and approved by his Honor the Mayor, the Comptroller, and the Commissioner of Public Works, who are now, by law, authorized to make provision for lighting the streets of this city.

Adopted by the Board of Aldermen, December 21, 1876.

Approved by the Mayor, December 23, 1876.

F. J. TWOMEY, Clerk of Common Council.

On an examination of the grants hereunto annexed, and which have been briefly referred to in the foregoing, it will be observed that neither of them contain any clause or conditions whereby the city authorities can compel the furnishing of a supply of gas to the public or private buildings, or to the public street lamps, except upon the terms fixed by the respective gas companies. The commonalty of the City of New York grant to these corporations valuable franchises, and it seems to me both just and proper some especial favor or privilege should be given the municipality in return. There can be no good reason why the city should be compelled to pay the same rate for the gas used in large quantities in its public buildings as are charged to the smallest private consumers, and it is but equitable to expect that all our public buildings should be furnished at a large reduction from the regular rates.

Very few, if any, restraints or obligations have been imposed upon any of our gas companies, their franchises giving concessions with the largest liberality in order that gas-lighting, acknowledged superior to any other artificial light yet discovered, might have nothing to embarrass its introduction into general use, for which its brilliancy, safety and convenience so strongly recommend it. Although the use of coal gas for lighting purposes was discovered as far back as 1792, when the enterprising Englishman, William Murdock, first constructed a small apparatus, and in 1798 a large and improved one, for lighting a factory near Birmingham; and in 1813 Westminster Bridge and parts of the streets of London were first lighted by the means of gas, and its use in this city having commenced in the year 1825, it being then made from resin at the works of the New York gas company, on the spot where Earle's Hotel now stands, and the first house supplied with gas in this city being No. 7 Cherry street, occupied by Samuel Leggett, whose gas bill for the six months ending November 15, 1825, called for 1,300 feet, at the rate of $10 per thousand, yet I believe the manufacture of illuminating gas is in its infancy. Experiments and improvements are being constantly made, and with favorable results, with the view of increasing its brilliancy and finding more economical methods for its manufacture, and I have confidence that the time is not far distant when our streets will be brilliantly lighted by other methods than those now in vogue, and that our citizens will be furnished with a superior quality of artificial light, or with gas for heating purposes, at rates much below those now paid.

The question of a good and pure gas supply is essential to the entire gas consuming community, inasmuch as the better the quality the less will be the consumption, with a greater illuminating power. Illuminating gas of the proper quality should, when tested by an Argand burner having fifteen holes and a seven-inch chimney, and consuming at the rate of five cubic feet per hour, give a light equal to the light of sixteen sperm candles of six to the pound, each burning at the rate of 120 grains of spermaceti per hour, and, as regards purity, should be free (within the limits of five grains of ammonia and twenty grains of sulphur to 100 cubic feet of gas) from ammonia, bisulphide of carbon, sulphuretted hydrogen, or other agents injurious to health or capable of deteriorating its quality or illuminating power. The improvements made, and being made, are yielding gas of a quality much superior to that above mentioned.

If the Corporation of this city make provisions in its contracts for a proper standard of gas, and the officials having the matter in charge see that the conditions are complied with, then every gas consumer will have the benefit of a good and pure article. With this view our contracts contain, as I believe, the necessary provisions, but under existing circumstances, we are unable to positively ascertain if the same are strictly adhered to. The only evidence we now have as to the quality of the gas, is the affidavits of the persons employed by the several gas companies to make their tests, and an examination of the records kept by the companies. Although I have every reason to believe that the terms of these contracts are complied with, yet it would be much more satisfactory were we enabled to ascertain the desired information through our own resources, and it seems to me very essential that this department should be in the possession of the necessary means for making regular and frequent examinations of the gas supplied by the different gas companies, both as to its candle power and its freedom from injurious ingredients, and also facilities for testing the burners used in the public lamps. With a room on Grand street properly fitted up, the gases of the New York, Manhattan, and Mutual companies could be examined, and with a room on 69th street we could examine the gases of the Metropolitan and Harlem companies. This city has in use in its numerous public buildings, many gas meters of various sizes, and in case of any doubt as to their accurate registering, we have no means of arriving at their true state, except by sending them to the state inspector of gas meters. All of these examinations could and should be done by this department, and in view of the advantages to be obtained by the city having the necessary appliances for all of the above inspections, I would recommend that suitable rooms be procured and fitted up for said purposes.

During the recent excitement on the gas question, caused by the advance in rates and the rejection of the bids, many arguments and suggestions have been brought forward by the public press and individuals in regard to the subject, and several methods for lightings and street lamps have been brought to my notice. It has been urged by some that the corporate authorities should establish works, lay gas mains, and enter into the manufacture of gas on its own account and for its own uses only, while others have claimed that the city could and should supply gas to the public as well as supplying them with water. The first proposition is entirely out of the question, and should not, under any consideration, be entertained, for with works erected and mains laid merely for the public buildings and lamps the cost of the gas would be greater than any company has ever yet demanded. It will be noted that there are nine organized gas companies in this city with ten works for the manufacture of illuminating gas, the united capital invested in this business amounting to $23,000,000, and, hence, as to the second proposition I am of the opinion that it would be extremely unwise and disastrous for the city to construct gas works, lay gas mains, and enter into the manufacture of gas and at the same time leave the now organized private corporations to continue their existence, to enter into competition with and, perhaps, make common warfare upon the works carried on by the city. Reference has frequently been made to the city of Philadelphia as conducting the manufacture of gas, but it should be remembered that in that city, as in Richmond, Va., and I believe in other places where the business is carried on by the city, that the municipal authorities control the entire production of illuminating gas, and hence, are not compelled to compete with private corporations. It will therefore be seen that the question of constructing gas works by the city is a matter requiring careful and serious consideration. I believe, however, if the Corporation could obtain possession of the works and mains of three of the companies now established, on just and reasonable terms, that gas could be manufactured and furnished to all our citizens at much more favorable rates than are now charged, but this is on the supposition that the business would be carried on in as careful and economical manner as the same is now conducted by private corporations. It is, perhaps, unfortunate that the Common Council of half a century ago, when fixing up the grants to the New York and Manhattan gas companies, did not provide for future emergencies by placing in these grants a stipulation providing, that at any time after the expiration of their respective terms the city would possess the right to purchase, and the companies be obligated to sell, all the buildings, pipes, etc., upon terms to be determined by commissioners duly appointed by the Supreme Court. With such a provision in these grants, and then by taking advantage of the condition of the third article of the grant to the Harlem company, the city authorities would be in a position to fairly consider the subject.

In view of the number of gas companies now in operation in this city, it seems to me desirable that some limit should be placed on a further increase of these franchises, for from experience it has been found that numerous gas companies in a city do not afford a guarantee of cheap gas in the future. Of course, for a time, competition goes on and rates may be reduced but the day inevitably arrives when some arrangement is made by the several companies, and then a common rate is agreed upon by all. It is far preferable that we should have a few companies with proper restrictions and safeguards for the public, than many companies with no restrictions to govern them. Another question to be considered is the gradual filling of the streets with gas mains, whereby these obstructions are found, and, hence, increased cost incurred in the laying of the city's water mains and the construction of sewers, while the continual breaking up of the roadways for the laying, repairing, and tapping of gas pipes, tend to keep the pavements in a constant state of disorder.

Section 73 of the City Charter, which authorizes the commissioner of public works, in conjunction with the mayor and comptroller, to contract for lighting the city with gas, prescribes that they "shall not make any arrangement or agreement with any company or companies for a period longer than one year at any given time;" and section 89 provides that "no expense shall be incurred by any of the departments, boards, or officers unless an appropriation shall have been previously made covering such expense." Under these sections of the charter contracts can only be made for the fiscal year, which is also the calendar year. In case the year is divided into two parts and proposals called for, as is now done, there is a possibility of the pavements being broken up, and numerous excavations made in the roadway, twice during the year, and a consequent disordered condition of the streets is occasioned thereby. On the other hand, if the proposal should be for the calendar year, as was lately the case, the gas companies are deterred from bidding for any lamps which are lighted by another in consequence of the expensive and arduous operation of removing the pavements and making excavations in midwinter, when the streets are liable to be covered with snow and ice and the earth is frozen perhaps two or three feet deep. To avoid these difficulties I would suggest that provision ought to be made by law, whereby contracts for lighting the public lamps may be arranged for a term other than the fiscal year, say from May to May. If this can be done, the city will gain much by further competition.

The burners now in use in our public lamps are of the same capacity (three feet per hour) as were originally introduced in this city in the early days of its gas lighting, when the streets were few and sparsely built upon; although the present burner is an improved one, and is much superior to those then in use, affording a larger and more brilliant light. I believe that a city of the wealth and population as ours should keep its streets well lighted for the comfort and protection of its inhabitants, and to do so should provide its street lamps with burners of a larger capacity than three feet. As it is my desire, however, to keep the expenditures of this bureau to the lowest possible figure, consistent with a proper and efficient management, I hesitate to recommend the adoption of a larger burner, lest the gas companies might use it is a plea for greatly increased and disproportionate rates. It might perhaps be well to provide, in the proposals for lighting the public lamps for the nine months commencing April 1st, for a three foot and a four foot burner, and that the gas companies be invited to name a price for each. On the rates being known, the Gas Commission can determine whether it is desirable to make any change.

In view of the very excessive annual expense of conducting the affairs of this municipality, I consider it absolutely necessary that every effort should be exerted to reduce, in some way, such portion of this expense as comes under this bureau, hence I desire to call attention to the large number of "extra lamps", now lighted in front of churches, schools, etc., of which there are 786 now burning and a charge upon the public treasury. By a resolution of the Common Council, approved February 12, 1851, the commissioner of streets and lamps was authorized "to place not to exceed two lamps in front of all church edifices which are used exclusively for divine services." Under this resolution all churches that have made application have two lamps, but in consequence of subsequent special resolutions, passed from time to time, several churches have four or six, and, in some cases, eight lamps burning at the public expense. I cannot see the necessity nor the propriety of having so many lamps, or of having them burning every night throught the year, more especially as many of these churches hold divine service but one night in a week,

and in some cases, no evening services at all. So, also, in the case of schools, some of which are never opened at night, while others hold evening schools but four months in the year. It may, therefore, be considered that many of these lamps are more for ornament than use, and I believe, that the annual outlay on this account is a burden which the taxpayers should not be compelled to bear.

In order that some portion of this expenditure may be avoided, I would recommend that a resolution be adopted by the Common Council, authorizing and directing the removal of all public lamps, in excess of two, which may now be in front of any church or school building, and also that they consider the propriety of having these lamps lighted only on such nights as services are held. This is the system adopted by this bureau for the extra lamps in the Twenty-third ward, on the annexation of the said ward. There the lamps are only lighted on such nights as services are held, and I can see no good reason why it would not answer every purpose in the old wards. It seems to me that the congregations of the various churches would have no good cause of complaint, taking into consideration the fact that it would, in a measure, reduce the amounts required for the lighting and care of the public lamps, and hence, would afford a proportionate reduction in the taxation for such purposes.

I would also recommend that new lamps be lighted in the newly made streets on the upper end of the island, and in the Twenty-third and Twenty-fourth Wards, only from time to time, as such streets are built upon, and when the owners and occupants of the houses require light. Resolutions are sometimes adopted ordering lamps to be erected and lighted in a street which is neither regulated nor graded, curbed or guttered, on which not a solitary house has been erected, and, in several cases, lamps so erected have had to be removed and reset, when the grading and guttering of the streets was under operation, thereby causing an additional expense upon the city. I would also advise that, in all cases where a new street is to be paved, and where the regular complement of street lamps are not then absolutely necessary, that the gas mains be laid and lamp posts erected before the pavement is put down; the stand pipes can be capped, and the lamps can then be lighted, from time to time, when and where they may be required, and the breaking up of the pavement will thereby be avoided.

I deem it essential that the attention of the Common Council be called to the necessity of requiring lights to be placed on the columns of the elevated railroad, lately erected on Ninth avenue, as a safeguard against accidents which are likely to occur under present circumstances. On an examination of this avenue it will be seen that these columns have been placed in the roadway of the avenue, and directly in the centre of the intersecting cross streets; and hence, on dark or stormy nights, there is a possibility of accidents by vehicles being driven in the darkness against the columns, and, in such case, either the city or the railroad company would be liable for the damage which may occur. I would therefore recommend that a resolution be adopted requiring the railroad company to provide proper lights at these places.

Lamp posts having been frequently erected in many of the streets in the upper sections of the city at irregular and various distances, a table has been prepared prescribing the number of lamps which shall be hereafter erected on the blocks in that part of the city lying north of Thirty-fourth street, and the table issued to the Harlem gas company is hereto annexed, marked "T."

A resolution of the Common Council having been adopted, and approved by the Mayor, directing the lighting of the piers and bulkheads of the city, I shall under your direction, and with the co-operation of the Department of Docks, commence the work before the opening of navigation, and have the principal piers used for passenger landings lighted by the time our river steamers commence their regular trips.

In September last lamp posts of a neat and economical design were erected on the High Bridge, and its approach on the Harlem side, and lamps lighted; thereby making this bridge a pleasant and favorite crossing for the residents of that vicinity who may have occasion to pass from the New York to the Westchester side, or vice versa.

On the annexation of the Twety third and Twenty-fourth Wards, the lamp posts and lanterns situated therein were found to be in a very bad condition; the same being corroded with rust, were falling into decay, and presented a very discreditable appearance, and they were rapidly growing worse and worse in consequence of the want of paint. In the month of October arrangements were made, under a special agreement, whereby all the lamp posts were thoroughly scraped and cleaned from rust, painted with one coat of metallic paint, and all the lanterns with two coats of paint on the inner and outer side, for the sum of 35 cents each, including post, lamp iron and lantern. This work has now been completed, the public property has been preserved, and the street-lamps in these new wards now present an favorable appearance.

There are other matters to which I desired to call attention, but the length of this report forbids. However, I shall take occasion, from time to time, to make such suggestions and recommendations as I believe conducive to the public good.

Having occupied the position of Superintendent of this Bureau only from the first of December last, and having been engaged the most of such time in closing up the business of the year, and in the investigation of several methods of lighting the city or parts thereof, I have had very slight opportunities of paying much attention to the outside duties of this office.

All of which is respectfully submitted,

S. McCormick,
Superintendent of Lamps and Gas.

[To be continued.]

The Chemistry of Gas Manufacture.

By A. Vernon Harcourt, Esq., F.R.S.,
One of the Metropolitan Gas Referees.

[A course of Four Cantor Lectures delivered at the Society of Arts, London.]

First Lecture.—Monday, March 5.

I propose. this evening, to give you, in the first place, a short account of the formation and chemical nature of coal, and afterwards to offer a general view of the subject, which I shall deal with more in detail in succeeding lectures—namely, the result of the application of heat to coal, especially in connection with the manufacture of coal gas.

Coal was formed from the air by a process, the beginning of which we are all familiar with, through watching the growth of vegetation.

The air consists, as you know, chiefly of oxygen and nitrogen, so that in 100 volumes there are about 78.4 volumes of nitrogen, and 20.6 volumes of oxygen: but it contains also small quantities of two other substances which for vegetation are much more important—namely, water and carbonic acid. Of water it contains ordinarily about 1 per cent. and of carbonic acid no more than .04 per cent. Nevertheless, it is on the presence of these substances in the atmosphere that the growth of vegetation depends.

The plants which grew at the time when our main supplies of coal were formed, differed greatly from those which exist on the earth at the present time; so much so that very few of them can now be referred by botanists to any existing genera. I owe to the kindness of Prof. Tennant some diagrams which are now upon the walls, giving examples of a reconstruction of those plants. The remnants or impress of them are chiefly found not on the coal, but in the shale which underlies the coal, and which has preserved the record more perfectly than the more alterable, softer matter of the coal itself.

Although the actual genera are different from those which now exist, yet we may compare these plants with various existing genera. For example, this *Lepidodendron*, of which a portion is drawn here, appears to be a plant of the same kind as the small club moss with which we are familiar, but on a gigantic scale.

Again, there are representatives of the tree ferns and of the coniferns, of which I have here some drawings. Then there is what seems to have been a large tree, which is called *Sigillaria*, because of the marks, as if impressed by a seal, existing on its stem; and what was formerly supposed to be a separate plant, but has now been proved to be only the root on which the trunk grew. These roots or stools have been preserved more abundantly than the trunks, so that often where the trunk seems to have entirely disappeared, the roots remain, and as they were supposed to be different, they received the distinct name of *Stigmaria*.

Then, again, another variety of plant, which seems to have abounded in the coal measures, corresponds to the *Mares Tails*, which now grow in marshy places or equiseta. It is, however, uncertain whether the predominance of these varieties in the fossils of the coal measures depends on their greater abundance amongst the vegetation of that period, or rather upon the fact that they have better resisted the influences producing change to which this deposited vegetation has been subjected. Some interesting experiments were made several years ago by Pror. Lindley on the powers which different plants possess of resisting decomposition, and he found that out of 177 kinds of plants which he left for two or three years under water, there were only fifty-six which had not wholly disappeared, and among these were the representatives of those varieties which are found in abundance in the coal measures, rendering it thus probable that the preservation of the forms of these plants may be due rather to their being able to resist the protracted action of water than to their greater abundance.

What may have been the nature and appearance of the forests or jungles which overspread a large portion of the earth's surface, for countless generations of vegetable life, must remain but dimly known. In coal itself the very traces of organic structure are almost wholly obliterated. All that we can say confidently is, that coal consists of the mineralized vegetation of a former period.

As to the way in which it has been accumulated, there were amongst geologists, some years ago, two rival theories. One view is that coal consists of the remnants of plants falling where they had stood, and that by a process of gradual decay, such as is now converting the heather of our moors into peat, these great masses of vegetable matter were accumulated, and converted into a more or less homogeneous mass. The interstratification of these deposits with sandstone, limestone, and shale is supposed to have come to pass in the following manner: After these plants had grown and died for many generations, the portion of the earth where they grew was flooded, the vegetation was destroyed, and, during the time that it was submerged, mineral matters were deposited, where the plants had grown. This submergence, also, we must suppose to have continued for a very long time; then the sea, or more often, it would seem, the fresh water, retiring, plants were again sown, and vegetation again throve for a long period; and thus the cycle of changes repeated itself. Probably this is the true account of the formation, at any rate of the greater part, of the coal that we have. By this alternating deposition of vegetable and mineral matters, we have the state of things which an examination of the earth's crust reveals, and which is well illustrated by the section of the coal measures of the Forest of Dean, which Mr. Warington Smith has lent me. Represented by this grey band is the new clay, which seems to have been the soil in which the plants of the coal measures grew. Then there is an accumulation of coal, the vegetable matter stored up; afterwards there was a period of inundation, and of deposition of mineral matter, which went on accumulating for a long time. The thickness of these strata represents in some sort the length of the periods of time which intervened between each change. The breadth of the black line represents, relatively to the rate of deposition of the organic matter, the length of time dur-

ing which the forest flourished. Then followed the deposit over it of sand, now compacted to sandstone, for a length of time, through a long alternation of periods here recorded in strata, and so on. No doubt the tax on the imagination of receiving a view of this kind is very great, especially if we figure to ourselves how long a period is required for the storeage of the amount of vegetable matter which a single coal seam represents. The greater part, no doubt, of the carbon of these plants passed away into the air and disappeared, as the plants disappeared in Prof. Lindley's experiments. Then we have to suppose those changes happening far inland, and simultaneously over a great portion of the earth's surface.

The other hypothesis to which I referred is, that these deposits have been formed chiefly from vegetable matters carried down by rivers. There are examples of such accumulations at the mouths of the Mississippi, and other large rivers, which best illustrate this hypothesis where there are great floods, and quantities of vegetable matter borne down and deposited in the delta of the rivers. What seems likely is, that both these causes have been in operation. But the extent and continuity, and even thickness of the seams of coal, and the fact that trees are found standing upright with their roots still bedded in the under clay, make it probable that the former hypothesis truly represents the principal mode in which coal has been accumulated. But wherever the storage of vegetable matter and the deposition of great masses of other materials upon it, so that it has become deeply buried in the earth's crust, and subjected to a high temperature and great pressure—wherever this has happened, there has occurred the process by which coal is formed.

Then, besides the deposition of the vegetable matter, we have also to account for the change which it has undergone. The two principal causes which have concurred in producing this change are pressure and a high temperature. We know that now, as we descend through the earth's crust, the temperature rises at the rate of about 1° Fahr. for every sixty feet that we descend. It is to be remembered also, that of the coal which we can now reach, or which comes within the 4000 feet of depth fixed by the Royal Commission as the greatest depth from which we should ever be likely to succeed in winning coal, much, at any rate, has been at another time at a greater depth beneath the earth's surface than we now find it, and that afterwards, by disturbance in the crust of the earth, it has been carried up to its present level.

Bischof has gone into the question of the nature of the changes by which woody fibre may have been converted into coal, and pointed out that there are various chemical changes by which this may have been effected. The abstraction of water, carbonic acid, and carburetted hydrogen, or of any two of these, produces an effect which may generally be described as a removal of a portion of the oxygen and hydrogen from the woody fibre—the carbon remaining behind in larger proportion. That, at any rate, is the nature of the principal difference between wood and coal, that oxygen and hydrogen exist in larger proportion in wood, and that the change by which coal has been produced has consisted in one way or the other in their more or less complete abstraction.

Another change, and one, perhaps, harder to understand, has gone on at the same time. Not only does coal differ from wood in the proportion of its organic constituents, but it differs from it in a remarkable way in its mineral constituents. The ash of coal is a very different thing from the ash of wood. Moreover, the ash of coal is almost the same as the ash of shale, and we must therefore suppose further that the coal, or the material of the coal has been exposed to the action of water carrying mineral matters, either in solution or suspension, for a sufficient length of time for its own mineral ingredients to be washed out, and those which were borne in solution or suspension by the water to have been substituted for them.

There, on the wall, is a diagram, showing the position of the coal measures in the series of strata down from the surface of the earth, which may serve to illustrate the great depth where all these strata are superimposed of the formation in which the coal lies.

I pass next to the changes which are produced in coal by the application of heat. Such changes occurred independently of man's agency, and at a period long before man appeared upon the earth. We know that in several parts of the earth it has been observed that inflammable gases issue from the ground. At Chatt Moss, in Lancashire, it was observed long ago—that by simply making a hole in the ground, placing a pipe in the hole, and applying a light, a flame could be maintained for a long time; and actually such gas has been applied to the lighting of buildings. Then, again, not only does nature make gas, but in making gas nature makes coke. Anthracite is natural coke—it is coal which has been exposed to a high temperature, and thus has undergone the same changes which we produce in coal by exposing it to artificial heat. When coal is heated, the change it undergoes depends upon the temperature to which it is heated. Probably the meaning of this is, not that coal, speaking of it as one substance, undergoes different changes, according as it is heated quickly or slowly, but rather—which, I think, is the true explanation of the matter—that, when it is heated quickly, the products which are first produced by heating it are exposed to the high temperature before they can escape. Probably the effect of heating coal quickly to a high temperature might be perfectly imitated by subjecting the products of its decomposition at a low temperature subsequently to a high temperature. This may be difficult to effect on a manufacturing scale, or may have no economical advantage. I believe something of the kind has been tried, but the true account of the matter is probably this—not that the same substances undergo chemical changes different according as they are exposed at once to a bright red heat, or gradually and gently heated; but that, when coal is treated in the way in which it is treated in a gas retort, and is suddenly exposed to this strong heat, the substances which would be simply distilled from it, if it were first heated gently, come into contact with strongly heated surfaces, and thus undergo a further change. The difference in the result is, that coal which is gradually heated gives off a much larger proportion of liquid, and a much smaller proportion of gaseous products, than coal which is suddenly heated strongly.

When the process of heating coal for economical purposes was first introduced, I believe the object in view was not the production of gas, but of the liquid and solid products. In 1781, Lord Dundonald took out a patent for the distillation of coal, his object being to produce *brown oil*, as it was called, naphtha, ammonia, and coke; but the gas was let go. Works for this purpose were in operation for nearly 50 years at Muirkirk, in Ayrshire. A curious circumstance in connection with these works is, that among the coal which was thus treated was found some cannel, which was thought to be unsuitable and thrown away.

I have here a miniature gas-works, lent by my friend Mr. Fison, which is now in action, and shows every step in the manufacture of coal gas, the heating of coal in the retorts, condensation of tar, ammoniacal liquor, washing, purifying, storage, and distribution. There are also on the walls a set of diagrams, lent me by Dr. Frankland, illustrating the same operation.

The solid residue, when coal has been heated in the retorts, is the well-known substance called coke. The same substance or very nearly the same substance, is also produced in cooking-ovens for use in locomotives, and for other purposes. It contains some three-fouths of the total weight of the coal which is distilled; and when the coal employed is a caking coal—that is, a coal which, when it is heated, is sufficiently bituminous to partially fuse, and so aggregate itself together—the coke remains behind in a solid piece, such as I have here. In many respects coke is superior to coal as a fuel. It has over coal the same advantage, for many purposes, that anthracite or steam coal has over other coal. You know that for use on board ship, and wherever a clean fire is required, the steam coal or smokeless coal is greatly preferred to ordinary bituminous coal. We do not commonly use coke for fires in our sitting-rooms; but I believe that this depends upon the form of grates which we are accustomed to use. A better form of grate has recently been advocated, under the name of Slow Combustion Grates, in which the air is not admitted to the fire from below, but only in the front. The effect of admitting air through an open grating beneath the fire, is to cause the coal to burn quickly away. If air enters from the front, combustion takes place, and each coal glows on the side towards the room. The grate should have a high and wide front, but be shallow from front to back, and have flat bars set edgewise, or rather far apart. The open space above the top bar should be no more than sufficient for putting on coals. In a grate of this kind, as I can testify from my own experience, coke can be burnt with the help of a little coal, just as well as coal, and with a better heating effect. I cannot but think that the consequence of a reform in our grates, which I hope to see, will be that this fuel will be largely substituted in domestic use for coal, to the advantage both of the householder and of the gas manufacturer. At times like the present, when the price of coal is lower than it has been, and the winter is mild, the quantity of coke which accumulates is very large, and the value of it to the maker is often very much below its real value. The reason we now use the bright or blazing coal in our fires is, that the air being admitted through the bars below, the chief part or the combustion goes on there, radiating heat only upon the hearth-stone, and the upper part of the fire, which is what we look upon, would be dull, unless we used a coal yielding a great deal of gas, in order that we may have a blaze at the upper surface, and see something bright.

The gases which pass out from the retort consists partly of what are termed permanent gases, and partly of what are distinguished as vapours; that is, of gases which, under other circumstances, would not be gases but liquids.

This distinction between gases and vapors is more misleading than it is serviceable. When we speak of a substance which is perfectly gaseous as a vapor, we recall by that word a circumstance which is generally quite irrelevant—namely, that under other conditions, if the temperature and pressure were different, this substance would be a liquid. Most probably the same is true of every gas; we know it to be true of all gases except six. It is as though we restricted the word "liquid" to permanent liquids like alcohol, and had another word for liquids which could be frozen. However, at the ordinary temperature a great deal that is gaseous at the high temperature of the gas-retort becomes liquid, and so is collected separately. I have on the wall two long tables, giving the names and the chemical formulæ of the great variety of substances which have been found among the products of the destructive distillation of coal. You will see that in one table all the substances, whose names and formulæ are given, consists of combinations of two only of the elements of coal—hydrogen heading the list, and all the other substances being combinations of it with carbon. Those which stand first on the list—hydrogen and marsh gas—are both permanent gases, which have never been liquefied. The others are substances which exist in the gas, and which are also partially condensed with the tar. They are grouped here according to their chemical classification, not according to their volatility. Those which come lower down are liquids. Paraffin is the name generally given to a solid substance that is obtained from coal, and it is given also by chemists to both liquid and gaseous substances which have the same general formula, $C_n H_{2n+2}$. Acetylene, again, is a gaseous hydrocarbon; then come some of the principal of the liquid bodies that are produced. Naphthalene is sometimes gaseous and sometimes, unfortunately, solid. It is liable to be deposited, and to obstruct gas-pipes at a distance from the works. Anthracene—a substance of which I shall have more to say presently—is also a solid substance. Then there arthers into which oxygen, nitrogen, and sulphur ene

ter, in combination with carbon, or hydrogen, or both.

This other table gives the results of a number of analyses of the different kinds of coal. The varieties of coal range, shading one into the other, from that containing the largest proportion of carbon—namely, anthracite—to highly bituminous coals, passing on into cannel coal, and into a substance about which there has been a dispute whether it is coal or not. This is Boghead cannel. This still richer substance of which Mr. Evans has kindly sent me a specimen—Boghead shale, as it has been called, from its resemblance to Boghead cannel—comes from Australia. You will see, from the specimens I have here, how extremely these substances differ in appearance from each other; indeed, different samples of cannel coal differ very much from one another, some being quite devoid of lustre, and some being brilliant like anthracite. The more bituminous coals yield a larger proportion of liquid products. Coals are called bituminous, not because they contain bitumen—for this substance cannot be extracted from them—but because they yield it when they are heated. As to the actual substances existing in coal, very little is known, because the actual constituents of coal are extremely insoluble, and chemists have not succeeded, by the application of solvents, in extracting directly (by processes which will produce no change in the coal) substances they can isolate and examine. Thus it happens that our knowledge is almost entirely of the substances producible from coal by heat, and not of the substances—equally definite, no doubt—which already exists in it.

I shall have to speak in a subsequent lecture of the substances which enter into ammoniacal liquor, as it is called, but will pass now to the other of the two liquid products of the destructive distillation, namely, tar; and consider, in the time which remains, the nature of some of the products which have been obtained from it.

Tar is a mixture, in varying proportions, of a great number of different substances. When it is heated it is divided into more and less volatile parts. There distils from it first some water—indeed, a principal difficulty with the tar distiller is to get rid of the water with which the tar is mechanically mixed. After that there comes over a substance which the tar distiller calls "liquid naphtha," which is subjected to a subsequent distillation. Next there comes over a substance of higher boiling point, of a consistency which is almost solid—a buttery substance which is called "creasote;" and, lastly, there comes over a substance which is at first more fluid, but afterwards nearly solidifies, called "anthracene oil," because anthracine is obtained from it. That which first distils over has nothing characteristic in its appearance, being a limped, colorless liquid. In these bottles are the products of the subsequent distillation.

The crude naphtha is first acted upon by soda. It is brought into contact with something like one third of its volume of a strong solution of soda. It contains, besides benzol and other similar hydrocarbons, a quantity of another important substance—namely, carbolic acid. This unites with the soda, and the two together form a heavy liquor, on the top of which the lighter naphtha floats. The liquor is drawn off and mixed with sulphuric acid; it separates as it cools, into two layers, the lower one consisting of a solution of sulphate of soda, of which he makes no further use, and to draw off the carbolic acid. The naphtha is next acted on with sulphuric acid, which combines with the organic bases substances containing nitrogen as well as carbon and hydrogen, and the purified naphtha, now containing only hydrocarbons, is distilled. In this first distillation the greater part is collected together and a small quantity remains behind, which is rejected or mixed again with the crude naphtha. It is then what chemists call "fractionally distilled"—that is to say, distilled in a gradual continuous operation; while the runnings of the still are collected separately. The receivers employed are carboys; the order in which they are filled is noted; and, subsequently, an examination of their contents is made, and the liquid products classified accordingly. The examination consists in determining the boiling point of the liquid. According as the manufacturer wishes to have a hydrocarbon of a higher or lower boiling point—which depends on the demand in the market—he mixes with the first portions distilled a larger or smaller proportion of the subsequent distillate, so as to have either a larger quantity of somewhat higher boiling point, or a smaller quantity of lower boiling point. These two are called respectively 90 per cent. benzol and 50 per cent. benzol—meaning a liquid which is judged, from its boiling point, to contain 90 or 50 per cent. of pure benzol.

Benzol is a hydrocarbon, of which the formula is $C_6 H_6$, and it is associated with other substances—namely, toluol, xylol, cumol, and cymol—substances which are homologous with benzol. These substances form a series proceeding in arithmetical progression by a difference of one atom of the carbon and two atoms of hydrogen, the first having the formula $C_6 H_6$, the next $C_7 H_8$, the next $C_8 H_{10}$, and so on. They are all mixed together in the naphtha, and they are, to some extent, separated from one another, in the fractional distillation, by the tar distiller. The purest benzol which is ever collected by the manufacturer contains some admixture of the other substances; but I have been lent, by Mr. John Williams, some samples of these different substances in a pure condition. Here are benzol, toluol, and xylol. Their appearance is absolutely similar; all are mobile, colorless liquids; but we should find, if we were to place them in a flask with a thermometer, and heat them until they distilled freely, and observed the temperature, it would be in the three cases, 84°, 114°, 126°.

The actual distillates collected at the tar distillery consists of mixtures of these substances boiling at temperatures which differ according as the hydrocarbons of lower or higher boiling-point predominate. I have here some samples of the commercial products, which I obtained to-day, through the kindness of Messrs. Blott, from their distillery.

The sample next in volatility to benzol is called "solvent naphtha," the purpose for which it is employed being to dissolve india-rubber.

After a time, as the temperature rises, the liquid which comes over is found to be of too high a specific gravity, and unfitted for this purpose; it is called "burning naptha," and is sold for burning in such lamps as are used sometimes to light stalls in the open air.

The second product of the original distillation—namely, "creasote"—is a pasty mass, which, on standing, divides itself, to some extent, into an oil and a solid, the solid being naphthalene. The chief use of this substance is for pickling timber; especially, I believe, railway sleepers. The pieces of wood are placed in cylinders from which air is exhausted, and then this substance is let in upon them, and forced into their pores by the atmospheric pressure. The wood is thus rendered more capable of resisting exposure to moisture and the attacks of insects than it otherwise would be.

Some portion of the oil which drains from the semi-solid mass is also used for making lamp-black. It burns with a very luminous, fuliginous flame, and the soot which is formed is collected and called lamp-black.

The third product is "anthracene oil." This divides itself into a liquid and a solid. It is poured upon frames carrying a filtering material, and the oil runs through, while the solid remains upon the filter, and is afterwards transferred to bags, where it is allowed to drain, and is then more completly dried and freed from the adhering oil by pressure.

Here are the three substances: the anthracend oil, which has a solid layer now settling, the "green oil"—so called from its color—which is used for making grease, and thirdly anthracene.

I have here a pure specimen of the naphthalene, which is the solid substance accompanying the creasote; and also one of anthracene and carbolic acid.

Besides the three distillates, the tar which is distilled leaves this solid substance called "pitch;" which also is applied to various purposes, the principal, I believe, now being that of making artificial fuel. It is mixed with breeze, and the pitch serves as a sort of cement to compact together other combustible substances, the whole forming a serviceable fuel. It is also used for making artificial asphalte, and in preparing a kind of felt.

It has also been supposed that, by further distillation of this substance, a further quantity of the valuable anthracene might be obtained; but I understand that, although the substance yielded by the destructive distillation of pitch greatly resembles anthracene, there is found to be some difference between them, which renders it not serviceable as anthracene is. The solid residue of the distillation of pitch is that which I have here—pitch coke—a very pure form of carbon, being almost free from ash, since it is formed by the destructive distillation of a substance which itself has been gaseous.

I have only a few words to add about the substances which are formed from these; but it is the less necessary to go at length into that part of the subject, though it is very interesting and important, because some seven or eight years ago it formed the subject of a course of lectures given here by Mr. Perkin, who is the principal among those who have developed this important and beautiful industry.

One substance directly produced by the destructive distillation of coal is "aniline;" but this is not produced in large quantity, and is not easily isolated. It was found first that from benzol, a substance of some use in perfumery, it may be obtained by the action of nitric acid, the product being called nitro-benzol; and it was also found that by the reduction of this substance—that is to say, the replacement of its oxygen by hydrogen—it was converted into aniline. This reduction was first effected by the action of sulphide of ammonium; but it was afterwards discovered that it was effected equally well, and more economically, by the action of acetic acid and iron. So that though coal and coal tar are the great sources of aniline, it is not obtained directly from them, although it exists there, but indirectly from the benzol, the benzol being first transformed by the action of a mixture of sulphuric and nitric acid into nitro-benzol, and then the netro-benzol being further transformed by the action of reducing agents into aniline,

The first great discovery was that, by the action of oxidizing substances upon aniline, it was transformed into a black powder which was serviceable as a dye. By the action of sulphuric acid and bichromate of potash, aniline was transformed into a substance to which the name of "mauve" was given. Subsequently, in the hands of Mr. Perkin and others, this production of coloring matters from aniline received a very great development, and the conaequence was the production of a number of beautiful pigments which are familiar to all of us, and of which I have here some specimens which Mr. Perkin has given me There is, I think, no more striking or more beautiful result of the application of chemistry than that it should be possible, from such a substance as coal tar, to obtain substances at the very opposite end of the scale of mineral being, these beautiful colored products.

There is one other point only which I would name. From the anthracene oil, anthracene is obtained; and from anthracene, by a series of porocesses which it would take me too far to go into, a substance which had long been used and known—viz., "alizarin." The investigation of madder, some 40 years ago, showed that the coloring matter consisted principally of alizarin and purpurin, of which alizarin was the more important. Then followed the great discovery that, by a succession of operations upon anthracene, it can be transformed into the same substance which is the coloring matter of the madder root; so that now actually the use of madder as a dye stuff is, I believe, almost disappearing: its place being taken by what can be produced to greater advantage economically—namely the very same material produced from coal tar.

This is really the crowning triumph—at least, it is difficult to suppose it can ever be surpassed—viz., the application of chemistry to the arts; and with this I conclude the present lecture.—*Jour. of Gas Lighting.*

Fire-Bricks.

[A Paper read at the British Association, Glasgow.]

By Mr. S. Dunnacher.

The fire-brick question may be viewed from various sides. The owner of furnaces who uses the bricks, the man of science who has to do with their chemistry and other technicalities, and the brickmakers who manufacture them, should all have something to say on the subject. In the present paper, we will view it from the brickmaker's standpoint, and will strictly confine ourselves to that branch of the fire-clay trade indicated by the title.

* * * * * * * *

Silica, alumina, bauxite, carbon, magnesia, lime, are highly refractory, the two first named, silica and alumina, being the essential constituents of our fire-clays. Lime and magnesia, though practically indestructible by heat, fuse easily when combined with silica, and are consequently classed with oxide of iron, potash, soda, etc., amongst the impurities of fire-clay. Experiments are at present in progress with several of the ingredients named, and important results are expected in more directions than one.

The great variety of purposes for which fire-bricks are used, and the various, and even opposite qualities required in them, make it impossible that one brick can answer for all descriptions of furnaces. They require to stand strong heat, change of temperature, in some cases heavy pressure, and hard knocks, and also fluxing and chemical action of various kinds. For all these purposes we require not one, but a variety of bricks, and this variety we will probably find sooner or later in the different refractory substances at our disposal.

The age of a fire-brick depends upon the purpose for which it is used. In some situations it may be counted by minutes, in others by years: and some bricks will last for years in positions where others also bearing the name of fire bricks would be destroyed in as many weeks.

The name fire-clay covers a multitude of qualities, and fire-bricks differ to such an extent chemically, and as manufactured articles, that if their names were to indicate their qualities, rather than the general purpose to which they are put, a great many new names would require to be invented or imported. Although no one brick answers for all purposes, a great deal can be done in the process of manufacture to fit it for the particular use to which it is to be put; one requires to be solid and close-bodied, another porous and open; in certain special cases soft burning is preferred, while in others they cannot be too hard. As a general rule, fire-bricks should be hard burned. The shrink from the green state to the burned condition is generally about one-twelfth of the bulk, and if this is not entirely reduced in the kiln, some of it will require to be burned out of them after they are built in the furnace, and this must injure the stability of the furnace.

Mixing clays of different kinds has been recommended with the view of combining the good qualities of each, and more especially to increase or diminish the relative proportion of silica. This may do good in some cases, but as all fire-clays have their bad qualities also, mixing will, in many cases, increase the force of these, and so do more harm than good. Riley says, touching this point, "In considering the qualities of a fire-brick, chemically, the bases that have a fluxing action should be considered as a whole. A brick might contain more oxide of iron than it should do, yet on account of its being far from other bases, it might nevertheless be a good brick." We thus see that the number of the objectionable ingredients, as well as their aggregate quantity, has something to do with the result; besides a natural chemical combination, an artificial mixture might give the same analysis, and yet be very different as a fire-brick making material.

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To get a really good furnace, we must first procure the best materials for its construction; but after that much depends upon how it was built. If we were as careful about the lines of our furnaces as we are about the lines of our ships, and as particular about the quality of the materials and workmanship employed, as the importance of the subject demands, we might, in many cases, double their duration, without waiting for the possible discoveries of the future. However anxious we may be for improvement, in the meantime we must make the most of the materials we possess, and of our present knowledge of the modes of manipulation.

* * * * * * * * * *

The quantity of fire-bricks annually made in the Glasgow district, which is almost exclusively comprised in the counties of Lanark, Renfrew, and Ayr, will amount in ordinary times to eighty millions. In addition to this there is manufactured an enormous quantity of sanitary pipes, gas retorts, andother articles in fire-clay, both useful and ornamental.

* * * * * * * * * *

The clay is first broken with hammers and shovelled into the crushing mill. The bottom of the pan has rows of perforations through which the clay is crushed. Scrapers, attached to the pan beneath, throw it into an iron box, from whence it is lifted about twenty feet by means of an endless chain, fitted with elevator bucket, which deliver it into a cylindrical riddle eight feet long and two and a half feet in diameter; this is so placed that the riddled clay drops to a second set of elevators, while the pieces too large to pass through drop back into the crushing mill. This second set of elevators has two duties to perform. It either sends the fine ground fire-clay which is used as mortar in furnace building to an endless belt which carries it to the wagons on the railway outside, or the rougher brick clay to the tempering pans by means of a box sixty feet long, placed overhead. In this box there is a traveling chain fitted with slats by means of which the clay is dragged along. In the bottom of the box are four holes, to which four conductors are attached, one to each mill. These, from their position, are always kept full, and when the millman requires clay, he has only to draw a sluice at the lower end of the conductor, and the clay drops into the pan. He then turns on the water, and the mill is charged in a second or two.

For mortar clay a riddle with 196 meshes to the square inch is used, and for fire-brick clay one of 20 meshes. In preparing clay for glasshouse blocks, gas retorts, Bessemer tuyeres, and all large articles, a proportion of previously burned bricks or clay is added, to prevent cracking in the drying. Pug mills are generally employed for tempering where the clay is of a soft aluminous nature, but they are not suitable for hard, gritty, siliciona clays. When ready for moulding, the clay is discharged into small tipping bogies, which are raised by means of a steam hoist to the upper floor of the drying stove. It is there run along a little railway, from whence it is dropped down through suitable openings to the moulders' benches. By this method one man delivers the clay to nine or ten moulders. It has also the advantage of taking the traffic off the drying floor. Once in the moulder's hands, it is rapidly turned into bricks. A good workman with his carrier will make 2500 bricks a day.

Solid brass moulds are used for regular sizes, but for odd kinds and the larger sizes wooden moulds are employed. Iron, zinc, and glass have been tried; but hard brass has many advantages. The moulds are made a twelfth larger than the size of the burned brick, to allow for shrinkage. The face board on which the brick is made is covered with thick plaiding, and the trade mark is fixed upon it, so that making and stamping are performed in one operation. Machinery is successfully employed in moulding common building bricks from stiff plastic clay, and also in the manufacture of dry or semi-dry compressed bricks from various materials; but no machine has yet been made capable of taking well milled fire-clay as it leaves the pans, turning it rapidly into bricks and delivering them square and sharp-edged on to pallet-boards.

When the brick is moulded by hand, the moulder discharges it on to a pallet-board, the carrier then places another board on the top of it, and between the two the soft brick is carried with safety, and deposited on edge on the stove floor, where it remains till hard and dry, when it is taken to the kiln.

The defects most common in fire-bricks, with the exception of soft burning, are produced in the stone, and it is here alone that soundness and finish can be given to them. If the stove floor is uneven, the shape of the brick is spoiled; and if too much heat is applied, the bricks are warped and cracked. Some clays are very liable to crack when too quickly dried; and where stoves are badly constructed, this occasions loss, and injures the quality of the brick to a serious extent. Where some are cracked through, others are partially cracked, and so on through all the stages of cracking, up to the sound ringing brick. Bricks of this description give also increased breakage in the kiln, and indeed in every stage of their existence.

To meet all this, a recently patented construction of stove is employed. The stoves are 120 feet in length, by 36 feet wide, and are fired from one end. The drying floors are entirely formed with cast-iron plates, each four feet by two feet, by $\frac{3}{8}$ of an inch. These are smooth and easily heated. Underneath the iron floor there is another, formed of fire-clay slabs, four inches and three inches thick, which runs from the furnace end to the middle of the stove, a distance of sixty feet.

The fires and hot flues are underneath the fire-clay slabs, and between the fire-clay slabs and the iron plates forming the upper floor there is an air-space of eight inches deep; this communicates with the outer air at the gable over the fires. Each flue has its own air-space. By this means the stove may be fired up so as to heat effectually the back end, while too much heat on the furnace end is prevented by the current of cold air passing between the two floors, till it joins the lower flue at the middle of the stove, carrying with it the superfluous heat of the furnace end, and utilizing it where it is required. Two such stoves, of the dimensions named, are turning out from 20,000 to 24,000 bricks a day. Every brick is ready for the kiln the day after it is moulded. By this system of drying, the cost is lessened, while the production for a given space is nearly doubled.

Various other methods have been tried, such as exhaust steam in pipes or flues, and hot air, in a variety of ways. In such cases shelving is generally employed, and this entails extra labor and expense. The method just described is in every respect to be preferred, particularly where large production and perfect regularity are required.

When dry the bricks are wheeled to the kiln, where they are built up in chequered walls, each brick being nearly an inch apart. A kiln contains from 16,000 to 20,000 bricks; when filled the doors are built up and the fires kindled. The firing is done very gently at first, the furnace being open, and also the holes in the crown of the kiln; this is continued for two days till the damp is completely steamed out of them, after which the crown of the kiln is carefully closed, the draught is connected with the chimney, and the kiln is put on full fire.

This takes either two or three days, during which time it is steadily brought up to a bright white heat, at which it is maintained till the necessary sink in the bricks has taken place, after which the firing ceases, and the kiln is gradually cooled down,

The kilns are built in pairs, back to back, and are fired from the one side across; the boor is not cheqered, excepting over the flue which runs along the back, and through which the draught passes on its way to the chimney, either direct or through another kiln. The fires are on the hopper principle, something after the style of the Siemens' producer. They are supplied with hot air heated under the floor of the kiln, and in addition there is a good sized flue run from end to end of the kiln over the fires, through which cold air is supplied to each fire. Without this the front of the kiln would become too hot; with it this is prevented, and the air thus introduced, after passing through the kiln, which acts as a kind of regenerator, combines at the back with the unconsumed gases, giving great evenness of burning and also grea economy.

The Newcastle kiln is the one generally used, and here and there the old Scotch or Leeds kiln is to be met with, but these are too expensive in times of dear coal.

In conclusion, let us ask, How are we to meet the want, so frequently and urgently expressed, for "cheaper and better fire-bricks?" To some, cheapening suggests a reduction of price, but this would be no answer to the present demand. If the prise were reduced until it disappeared altogether, and the quality of the brick remained unsatisfactory, the want would still be felt all the same.

What is required is a superior quality, so that the price, whatever it may be, will be found to be cheap when viewed in relation to the service rendered. Something may yet be done to economise fuel, and machinery may yet reduce the item of wages, and at the same time improve the condition of the workman; but if the requirements of modern metallurgy in this matter are to be fully met, it must be principally by the improvements of the quality of our furnace materials.

THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

A. M. CALLENDER & CO.,
PROPRIETORS.

Editor—G. WARREN DRESSER.

PUBLISHED ON THE 2ND AND 16TH OF EACH MONTH
At No. 42 Pine Street, New York.

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IGHT, HEAT, MINING INTERESTS, STEAM,
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OSTON—S. M. PETTENGILL & Co., 6 State Street.
HILADELPHIA—COE, WETHERILL & Co., Ledger Buildings, Phila.
Germany—B. WESTERMANN & Co., of New York.

WEDNESDAY, MAY 16, 1877.

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—ED.

Photometric Experiments by Dr. Kidder.

47 INDIA STREET, BOSTON, May 1877.

Mr. Editor: Wishing to correct a general and legalized error, I here present an account of some experiments in photometry, made by myself in the winter of 1869–70.

Being engaged in the investigation of the value of the vapor of petroleum naphtha for carburetting or enriching ordinary coal gas, I employed different forms of burners with such widely different results, as led me to inquire as to the cause. I found that with a certain quantity of naphtha added to the gas, its illuminating value, when burned from an open bat's wing or fish tail burner, was increased 100 per cent., but if the ordinary Argand burner was employed, instead of the fish tail or bat's wing, an increase of 60 per cent. only was shown. This was several times repeated to eliminate any possible error, and found to be a law as between the two different burners with thirty candle gas: similar comparisons with fifteen candle gas showed but half the difference observed with the thirty candle gas. Next come the inquiry, "Why is this thus"? It was assumed that the difference in the arrangement of the two flames must be held to account for it. Bearing in mind that ordinary photometric examinations only deal with the light emanating from one side of a flame, which I will call the proximal or candle side, let us compare the two burners. The fish tail or bat's wing is practically a single flame, although composed of two, separated only by the thin septum of gas between the burning surfaces. The argand is practically a double flame, or two flames' each composed of two burning surfaces, with the interposed septum of gas, and one of these flames is behind the other in a line with the candle; it is, as it were, a bat's wing flame folded upon itself, so as to present but one half the luminous area to the photometric discs. From these premises it became evident that the obstruction of light from the proximal side of the distal flame, by the solid carbon precipitated and floating in the proximal flame, must account for this difference; to prove which I placed in line with the candle five fish tail burners of equal size, and supplied with thirty candle gas, the first showing thirty candles, the second added but twenty, the third about thirteen, a fourth eight, and the fifth about five to the measurable light. Thus in this series of five burners the aggregate loss from obstruction of the solid carbon in the flames was nearly one half.

A similar experiment with fifteen candle gas showed but half the obstruction from the solid carbon in the flame, as one gave fifteen, the second added twelve and a half, the third ten, the fourth eight and a half, and the fifth seven candles, the aggregate loss being but about one third.

Is it not hence evident that the open burner is far better suited to the photometric examination of illuminating gas than the argand, which, to say nothing of the modifications possible by which it may be made to tell so many different stories about the same gas, it is a "natural born" falsifier, whose testimony should not be relied upon. It is ever ready to give to poor gas a character better than it deserves, and in traducing rich gas it is equally capable.

Respectfully yours,
MOSES W. KIDDER, M. D.

A Correction.

BOSTON, May 8, 1877.

Mr. Editor: I notice that in the proceedings of the last annual meeting of the New England Association of Gas Engineers, the names of the Committee on Statistics were omitted. On page 170, 2d column, after the paragraph "It was therefore voted that the list in the hands of the President, etc." should have been inserted the following: The chair appointed as that committee, Messrs. Stedman, Cabot, Neal, Slater and M. S. Greenough.

Please make the above addition to the report in your next issue, and much oblige

Yours truly,
GEORGE B. NEAL.

Retort Gas Stoves.

It is a well known fact that a large per centage of the maximum heat of ordinary fuel, such as coal and wood, is lost by escape through the flue, and this in spite of the most approved modern apparatus. Combustion, as conducted in the ordinary stove, is far from perfect, hence the necessity of fluent draft and easy means of egress for the products of such combustion. The residuum precipitate of combustion in solidified hydrocarbons is ash mixed with stone, slate, etc., impurities practically inseparable from coal. Ignition in anthracite coal is difficult, hence a large body of fire is required to establish the chemistry of combustion. These facts prove the necessity of certain inconveniences which must be considered a part of the labor attending the development of a practical heat from anthracite coal.

The excuse for the universal employment of anthracite for cooking and warming purposes is its cheapness, as compared with other means of accomplishing the desired end. In the consumption of coal we burn the gases residing in the material; why not use the gases without being obliged to put up with the inconvenience of the tardy ignition, the ash, and the solid impurities. Again, during the summer months, the heat radiating from a common stove into the room, is the source of much discomfort and decidedly objectionable.

We would be pleased to employ a means for our summer cooking, which shall give us an effective fire, kindled into full heating power instantly; resulting in a heat practically all we require, applied directly to the point of utilization, and not attended by radiating loss, as a measure of economy and comfort to the person conducting the cooking; also, a fire without smoke or odor, capable of effecting every form of work now accomplished by the most approved coal or wood stove. Such an apparatus for summer cooking would seem to be *ne plus ultra*. One thing more to be considered—the expense of conducting such a fire. We practically demonstrate that coal gas at one-fifth of a cent per foot is capable of doing all this, and at an expense (determined by practical experiment) of 15 per cent. less than coal, by comparative cost of material only, not estimating the extra convenience of gas, and allowing nothing for its manifold virtue.

The Retort Gas Stove professes to accomplish all this—bake, broil, roast, toast, boil, etc., *better* than any coal stove in existence; and all done without ashes, cinders, smoke, or smell of combustion or gas, and to compete with coal relating to economy. The stove is simple and durable in its construction, and takes its name from its retort through which the gas is passed and *superheated*, thereby expanded before contact with the air. It seems unnecessary to enter into the advantages thus derived, for every gas company or engineer knows the advantage to be derived by thus preparing the gas for its perfect combustion.

In a published certificate, given by the State Assayer of Rhode Island, a competitive trial of the Retort Stove with four of those hitherto considered the best, results in an average gain of 47.39 per cent.

So favorably have these stoves been received by an appreciative public, that very many gas companies have solicited and obtained the local agency for the stoves, and are now advertising and pushing the sale, at their own expense, expecting to be fully compensated for this liberal policy by the increase of the distributing account. There seems to be in this enterprise an object of *vital interest* to the gas company which commends its serious attention to the subject as a matter of business prosperity.

Foreign patents have been taken out, and stoves are now being shipped to other countries. It would certainly seem that there is something of more than ordinary interest in this stove, to have attained so extensive a reputation in less than one year.

Gasoline Lamps.

The residents of Harlem are considerably exercised just now over some complaints of explosions taking place in the gasoline street lamps with which that portion of the city has been lighted for some weeks past. Reports of quite a number of explosions have been recently published, and rumors of so many more have been circulated in this district, that a feeling of uneasiness has been created, and people passing the lamps are beginning to feel somewhat nervous lest fragments of shattered glass may injure them. Reports have also been current that these lamps are liable to go out, and that whole blocks are frequently left in darkness on this account. A *Herald* reporter visited Harlem yesterday to ascertain what amount of truth there was in these reports, and to ascertain the number of explosions which have taken place since gasoline has been used for lighting the streets in the vicinity.

At the Twelfth precinct station house, in East 120th street, the reporter was informed that but one explosion of a gasoline lamp in that precinct had been reported for some time. The blotter showed that the explosion referred to occurred on April 27th, the lamp being No. 2,314, situated on Second avenue near 119th street. A man named Leahan was lighting the lamp when it exploded and burned his right hand. The sergeant said he thought there had been another explosion, but could find no record of it. The light in the lamps, he said, go out easily, especially on a windy night, and on one night as many as 150 had been reported in that precinct as having been extinguished. At the Twenty-third precinct station, in Eighty-eighth street, between First avenue and avenue A, it was found that only one explosion had been reported, and that occurred some three weeks ago, on the first night on which the gasoline was used. The air, the sergeant at the desk said, gets in the lamps, and if the wind is strong many of these lamps are sure to go out. That could be remedied, however, by improving the construction of the lamps.

Inquiries made among the storekeepers and citizens generally in Harlem, showed that opinion is greatly divided as to the merits of the gasolene lamp. —*N. Y. Herald, May 6.*

Prices of Gas Coals.

We continue our quotations of the standard gas coals.

Westmoreland	$5 50	$4.50)	at Baltimore.
Penn	5.50	4.50)	
Despard	5.35		
Marion	5.35		
Murphy Run	5.35		
Ches. and Ohio R.R. Caking Coal	5.40	4.25	at Richmond.
Block House	4.50	1.75)	Gold f. o. b. at Mines.
Glace Bay	4.25	1.50	
International	4.25	1.75)	
Clover Hill	4.00		
Newcastle	4.25		
Cannelton Cannel	10.00		
Peytona	10.00		

Freights from Baltimore to parts east of Cape Cod are nominally $1.75—making the cost of the Westmoreland and Penn coals about $6.25; at Boston and vicinity an advance of nearly fifty cents over last years cost for the same coal; the figures remain without material change from our last issue. Contracts for the delivery of domestic coals in New York and New England have been very light up to the present time compared with previous years, and those that have been made are mainly with companies whose facilities for receiving their supplies are restricted, and who cannot avail of the competition from foreign coals.

The arrangement between the Penn'a Rail Road and Baltimore & Ohio Rail Road, which not only regulates the prices which the coal company shall charge for their coal, but actually dictates to the consumer what he *shall*, and what he *shall not* use, is not looked upon with favor by either the coal companies or the consumers. The majority of the officers of our gas companies feel that they are quite as competent to select the coals best adapted for their works, as the freight agents of the railroad, over whose lines the coals have to be transported; a material and healthy competition between the different sources of coal supplies in this country, will not injuriously affect the interest of any one of the railroad companies, so long as the latter confine themselves to the business of common carriers; but, when they depart from their legitimate business, and undertake by illegal and unjust means to restrict honest competition, and deprive the owners of properties located on their routes, of the ordinary facilities for reaching market, the result cannot be otherwise than disastrous in the end. Up to the present year the consumers of gas coals have been free from the combinations that have attended the other coal interests of the country, and the result has been the developement of some of the finest gas coal mines in the world; there is no known caking coal at all accessible to our gas companies that will compare with that produced in Western Pennsylvania and some parts of Virginia. The care exercised in its preparation for market is largely the result of the competition between the different producers, each of whom is anxious that his coal shall reach the consumer in the best possible condition. Take away this competition, and restrict the producers to one or two coal companies under the directions of the railroad freight agents, and all necessity for careful selection and preparation of the coal for market is removed.

A recent decision in the Court of Appeals of this state, relative to combinations to control productions, traffic, *and prices*, with a view to benefiting a few favored operators, bears directly on the existing agreement between the two railroad companies referred to above; contracts made with consumers under such combinations, are declared of no legal value, and render the parties to them liable to criminal prosecution.

Two of the principal coal companies on the line of the Baltimore & Ohio Rail Road, are now prohibited from entering the New York market with their produce, by a tariff which imposes nearly *two dollars per ton* more freight on their shipments to Baltimore than is charged adjacent coal companies to the same port. That such injustice can long be allowed to exist is not to be believed.

Some additional sales of Provincial coal have been made for delivery in New York and New England. prices varying from $4.00 to $4.50 currency, according to port of shipment and delivery; the latter quotation is for Block House. We hear of some orders having gone forward for Newcastle coal for delivery at New York, under limits of $4.00 to $4.25. The demand for tonnage to load grain hence to Europe may lead to *some importations* of this coal, later in the season.

Sales of Cannel are now confined almost entirely to those companies located in the Kanawha Valley. Most of the gas companies have ample supplies for the present; but the increasing consumption of this article will likely lead to some material contracts in the course of the next 30 days.

Gas-Light Intelligence.

United States.

GAS IN THE CITY OF NEWARK, N. J.—The Newark Gas-Light Company, and the Citizens Gas-Light Company of the above city, at the request of the city authorities, consented to an abrogation of the contract for lighting the public lamps and buildings, said contract having yet four years to run. The city requested a reduction from $33 to $28.70 per lamp, per annum. It was estimated, by the Finance Committee of the Common Council, that this reduction would, in the four years' save the city from fifty-five (55) to one hundred (100) thousand dollars. In consideration of the liberal concession, the exclusive right for lighting the city has been given to the two companies now supplying the city, for ten (10) years from December 1st, 1876.

REDUCCTION OF CAPITAL.—The Citizens' Gas Company of Troy intend to reduce their capital stock $50,000.—*N. Y. Telegram.*

OBITUARY.—Wm. H. Perry. Mr. Wm. H. Perry, Superintendent and Clerk of the Bangor (Me,) Gas Light Company, died in that city on Friday evening from the effect of a stroke of paralysis with which he was seized on Monday. He was a native of Hardwick, Mass, whence he removed after reaching manhood to Bucksport, Me. He became a resident of Bangor in 1832 or 1833. He was a careful and industrious business man, and was much esteemed by all who knew him. He was 68 years old and leaves a wife and four children.

[Mr. Perry was one of the Directors of the New England Association of Gas Engineers, and the news of his death will be received with sincere regret by the members of the Association. His quiet and dignified manner, his courtesy and good judgement well fitted him for the position he held in the Association. It is another instance where the plain, honest, old fashioned, reliable man has passed away, leaving a vacancy that will be seriously felt.—ED.]

DEATH OF ABRAHAM MEYERS.—Abraham Meyers died at his residence, Harrisburg, Pa., April 2d, 1877. Deceased was, at the time of his death, engineer and superintendent of the Harrisburg Gas Co. His connection with the gas profession commenced with the erection and engineering of the Spring Garden Gas Works at Philadelphia, Pa., which works, after being finished, he superintended for eight years. In this time he erected the works at Norristown, Pa., also at Manayunk, Pa, now part of city of Philadelphia, Chambersburg, Pa.; and also re erected works at York, Pa., and also Harrisburg, Pa., and was for a time assistant engineer at Philadelphia gas department, and was for a time connected in business with Mr. Bryant, late proprieter of the GAS LIGHT JOURNAL.

Deceased stood high in his profession of gas engineering. His skill in the management and erection of gas works was highly appreciated wherever known.

THE NEW GAS COMPANY—We have headed our notice "The New Gas Company," which is a misnomer, the name, organization, and chartered rights of the company having undergone no change. But it passes into new hands, new management, new capital, new prospects, and with new enterprize and new aims. At the meeting of the Company yesterday, as will be seen by its action published elsewhere, it was resolved to cut down the price of gas from $4.50 to $3.60 per thousand cubic feet, and to abolish the rent of meters. This is to be immediately followed up by a complete renovation of the Gas Works, the improvements to embrace new machinery, buildings, and the rehabiliment of the works and grounds with a neatness and taste corresponding to their value. The Company will also have a centrally located office, which will accommodate those who prefer the discount of ten per cent. to be allowed on bills payable before the 10th of the month, a discount which really amounts to an increase reduction.

It is very probable that the new management is not moved by philanthropic motives in the liberal enterprises thus undertaken. The Company simply mean business. They look for such largely increased consumption as shall more than compensate them for their loss on price and which shall prompt other reduction of rates in the future.—*Muscatine, Iowa, Daily Tribune.*

Erata.

In the report of the meeting of the New England Association, page 176, bottom of middle column, is the word "Alexander" burner. This should be "London Sugg with self-regulating governor."

Gas Stocks.

Quotations by W. B. Scott & Co., Bankers,

24 PINE STREET, NEW YORK CITY.

MAY 16, 1877.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Harlem	$1,850,000	50	104	110
Manhattan	4,000,000	50	203	206
Metropolitan	2,500,000	100	130	136
" Scrip	$1,000,000	..	100	103
" Bonds	500,000	1000	92	94
Mutual	5,000,000	100	98	—
" Bonds, gold.	900,000	1000	105	—
Municipal	1,000,000	100	70	80
New York	4,000,000	100	131	132½
Gas Co.'s of Brooklyn.				
Brooklyn	2,000,000	25	170	173
Citizens	1,200,000	20	90	94
" Scrip	220,000	1000	95	97½
Peoples	2,000,000	10	40	45
" Bonds	$ 325,000	...	...	95
" Scrip	300,000	...	85	—
Metropolitan	1,000,000	100	76	80
Nassau	1,000,000	25	80	85
" Ctfs.	700,000	1000	96	98
Williamsburgh	1,000,000	50	130	135
" Scrip		...	98	100
Out of Town Gas Companies.				
Central, Westchester	466,000	50	90	95
Bath, Maine	70,000	100		
Buffalo Mutual, N. Y	750,000	100	55	—
" Bonds	200,000	1000	—	90
Baltimore, Md	2,000,000	100	134	134
" Ctfs., gold	1,000,000		106	110
Bayonne, N. J		100		90
Brockport, N. Y	25,000	100	...	80
Citizens, Newark	918,000	50	98	100
" " Bds.	124,000	—	—	—
Cincinnati G. & C co				190
Derby of Conn	160,000	100	60	80
East Boston, Mass		25	132	—
Fort Wayne, Ind		100	...	—
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	184	186
Hempstead, L.	25,000	100	...	—
Jersey City	386,000	20	160	—
Jamaica, L. I	25,000	100	...	—
Jacksonville, Ill	120,000	50	82	...
Lewistown, Maine	400,000	100	50	85
Lima, Ohio	60,000	100	—	...
Bonds	30,000		90	
Laclede, St Louis Mo	1,200,000	100	100	110
Long Branch		20		95
Peoples, Jersey City		...	120	125
Peoples of Albany	650,000	100	—	20
" Bonds	350,000	1000	—	—

Peoples of Baltimore		25	76	---
" Bonds....			106	---
Perth Amboy		25	---	95
Rochester, N. Y.....		100	50	60
Richmond Co., S. I.	300,000	...	97	160
Woonsocket, R. I....	150,000	100	100	...
Halifax N. S.....	400,000	40	148	150
Hamilton, Ontario...	150,000	40	117½	
San Francisco Gas-Co., S. Fr'isco Cal.			111	112
St. Louis, Missouri..	600,000	50	73	75
Stillwater, Minn.....	50,000	50	---	26
Suburban, W'stch'str	390,000	50	---	100
Saugerties, N. Y	15,000	100	110	115
Troy, Citizens.....	600,000	100	---	60
Toledo, Ohio.....			95	97½

The Metropolitan Gas-Light Company of Brooklyn have declared their semi-annual dividend of 2½ per cent., payable on and after the 20th inst.

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To Gas Engineers.

WANTED

By the Gas-Light Co., Saint John, N. B., Canada,

A COMPETENT ENGINEER to take charge of the Manufacturing Department, and to superintend all Extensions, Alterations, and Repairs on Works. The Company manufacture at present time about Forty Millions cubic feet of Gas annually. Testimonials, with age and salary expected, addressed to the Secretary, on or before the 17th May next, will receive immediate attention.

By order Committee of Management,

429-2t ROBERT BRITAIN, Sec.

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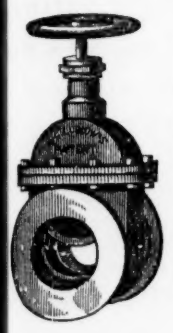

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KIDD'S

Gas Consumers' Guide

Enables every Gas Consumer to ascertain at a glance, without any previous knowledge of the Gas Meter, the quantity and money value of the Gas consumed. Also the best method of obtaining from Gas the largest amount of its light.

It will be to the advantage of Gas Companies to supply their Consumers with one of these Guides, as a means of preventing complaints arising from their want of knowledge in regard to the registration of their meters. For sale by

A. M. CALLENDER & CO.,
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Experience has fully demonstrated that the FORMATION OF HARD CARBON in Gas Retorts may be PREVENTED by avoiding the pressure produced by the Dip-Pipe Seal BY THE USE OF RETORT VALVES, and at the same time a large increase in the quantity and quality of Gas produced be effected.

THE GAS-LIGHT IMPROVEMENT COMPANY

call the attention of all Gas-Light Companies *TO THE ONLY VALID PATENT FOR THE USE OF RETORT VALVES* for the above-named purpose, the exclusive ownership of which is vested in said Company.

RETORT VALVES combining the latest improvements and Licences for the same, may be obtained at greatly reduced prices, by application at the office of the Company, No. 77 Kilby Street, Boston, Mass.

Blank forms showing the kind of dimensions required to fit Retort Valves to any Gas Works, will be sent by mail when requested.

The Gas-Light Improvement Co.

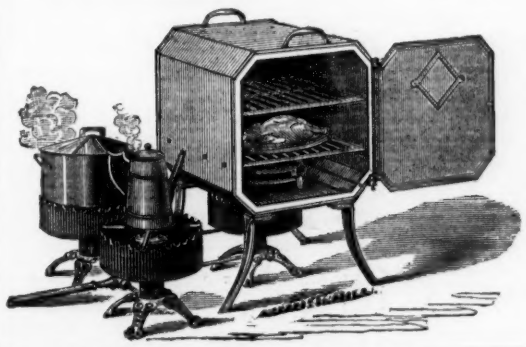
JOHN T. LANGFORD, General Agent.

CAUTION.

Gas-Light Companies are Cautioned against the use of any kind of Retort Valves for dispensing with the Dip-Pipe Seal, or any device in which any kind of Valve is used for that purpose, as they are all subject to Letters Patent No. 95,459, dated October 5th, 1869, granted to William Gibson, and now the property of THE GAS-LIGHT IMPROVEMENT COMPANY.

JOHN H. BLAKE, President.
429-2t **WILLIAM REED, Treasurer.**

THE RETORT GAS STOVE,



Constructed on an entirely new and scienti principle. By *superheating* the gas before it unites with the air, perfect combustion is obtained, and the same work as other stoves actually done, with 33 per cent. less gas. Does not heat up the room or the person using it. The *entire family cooking* can be done in *half the time* and at *half the cost* of coal, wood, or oil.

Is acknowledged to be the best, and sold by many gas companies.

Send for circular.

THE RETORT GAS STOVE CO.,
Providence. R. I.

T. DEAN, Pres't. } {H. N. SMITH, Treas.
S. F. DEWEY, V. Pres. } OFFICE OF {CHAS. F. DEAN, Sec.

THE GAS-LIGHT CO. OF AMERICA

Nos. 63 and 64 Drexel Building,

P. O. Box, 5131. NEW YORK.

THE GAS-LIGHT COMPANY OF AMERICA, owners of the Patent Processes for making ILLUMINATING GAS from PETROLEUM and its products, known as the

Gale and Rand

AND

Wren and Barker Patents,

are prepared to treat with Gas Companies and Manufacturers of Gas for the use of said processes.

An examination of the merits of these inventions as demonstrated by practical experience in a large number of Gas Works employing them, will not fail to convince the intelligent Gas Manufacturer of the great advantages derived from their use.

Gas of unexceptional quality, of high illuminating power is made at many of these works by these processes, at a cost of from 40 per cent. to 60 per cent. less than an ordinary quality of illuminating gas can be made by any other methods in use. Gas Companies generally may easily, and at small outlay for making the necessary changes in manufacturing apparatus, double their net earnings, and supply a much better light to their patrons, at greatly reduced prices.

The Company respectfully refer to Companies using these processes in this city, Reading, Penn., Chicago and elsewhere, and especially to the Mutual Gas-Light Company of Detroit Mich., whose works more nearly conform in all details of construction to the original plans of the inventors than those of other Companies.

For Correspondence, etc., address to office as above.

CHARLES F. DEAN, Secretary

OFFICE OF THE

NATIONAL COAL GAS COMPANY,

No. 4 Warren Street, New York.

H. P. ALLEN, President.
I. B. BRICE, Vice-President.
A. H. ALLEN, Secretary.
WM. J. VALENTINE, Treasurer.
GEORGE W. HARRIS. Engineer.

This Company is the owner of the GWYNNE-HARRIS, or AMERICAN HYDROCARBON process, for making Gas for Lighting or Heating purposes, by the perfect decomposition of superheated steam, under what is known as the

GWYNNE AND HARRIS PATENTS.

This process has been fully tested nearly 50,000,000 cubic feet of Gas having been made under it, and fully demonstrating the fact that it is the greatest improvement ever made in the manufacture of Gas, either for Lighting or Heating purposes. With half a ton of Anthracite Coal 150,000 cubic feet of Gas per day is made from three benches, and the labor is so small that one man can attend three or four benches.

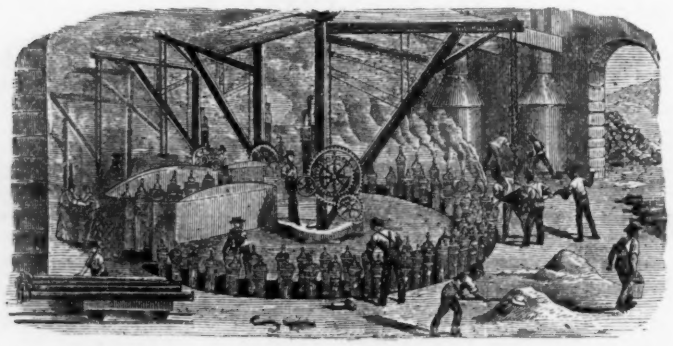
The process can be put into either Coal or Oil Gas Works (or where both Coal and Oil are used) at small cost, without any interruption to the working of other benches. The Citizens Gas-Light Company of Brooklyn, after using it for more than seven months, have found it not only far better, but actually *cheaper* than atmospheric air in making Gas, with the use of "petroleum and its products"

Further information, and terms of sale of rights will be given, upon application to the Company 348-1y

M'NEALS & ARCHER,

BURLINGTON. N. J,

Flange-Pipes



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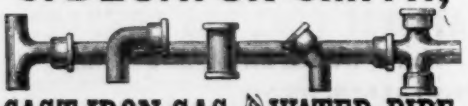

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Several Thousand 2, 3, 4, 6 and 8 Inch Cast Iron *Gas and Water Pipes* on hand, for immediate delivery.

☞ FITTINGS FOR GAS AND WATER MAINS. ☜

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BRANCH CASTINGS, LAMP POSTS, Etc.

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HEAVY AND LIGHT CASTINGS OF ALL KINDS.

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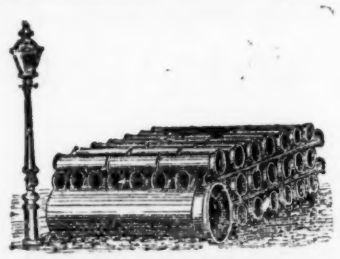

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251-1y

PEYTONA CANNEL COAL,

FROM WEST VIRGINIA.

Yields over 13,000 feet of Gas per ton. At ten thousand ...et (standard yield) the illuminating power is over **43** can...es. Purifies **4,510** feet to the bushel of lime.

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This Company offer their very superior Gas Coal at lowest ...rket prices.

It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of ...od illuminating power, and of remarkable purity; one ...shel of lime purifying 6,792 cubic feet, with a large amount ...f coke of good quality.

It has been for many years very extensively used by various ...as Companies in the United States, and we beg to refer to ...he Manhattan, Metropolitan, and New York Gas Light Com...anies of New York; the Brooklyn and Citizen's Gas Light ...ompanies of Brooklyn, N. Y.; the Baltimore Gas Light Com...any of Baltimore, Md., and the Providence Gas Light Com...any, Providence, R. I.

Best dry coals shipped from Locust Point, wharves, and ...rompt attention given to orders for chartering of vessels.

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To Gas Light Companies throughout the country.

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Mines in Harrison County, West Virginia.
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Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine

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Company's Office, 52 S. Gay St., Baltimore.

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SHIPPING POINT—Baltimore, Md.

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Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County, West V...ginia, delivered at RICHMOND, Va.:

CANNELTON CANNEL,

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CANNELTON CAKING COAL.

MAXIMUM YIELD, **5.06** cubic feet of Gas per pound of Coal—A yield of **4·78** cubic feet per lb.. —gave **16 14-100** Candle-Power.

COKE, of very fine quality—**1453** pounds produced from one ton of coal.

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For delivery at any Port in the United State

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Offer for Sale the

YOUGHIOGHENY COAL

DOUBLE SCREENED,

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Full particulars can be had by addressing

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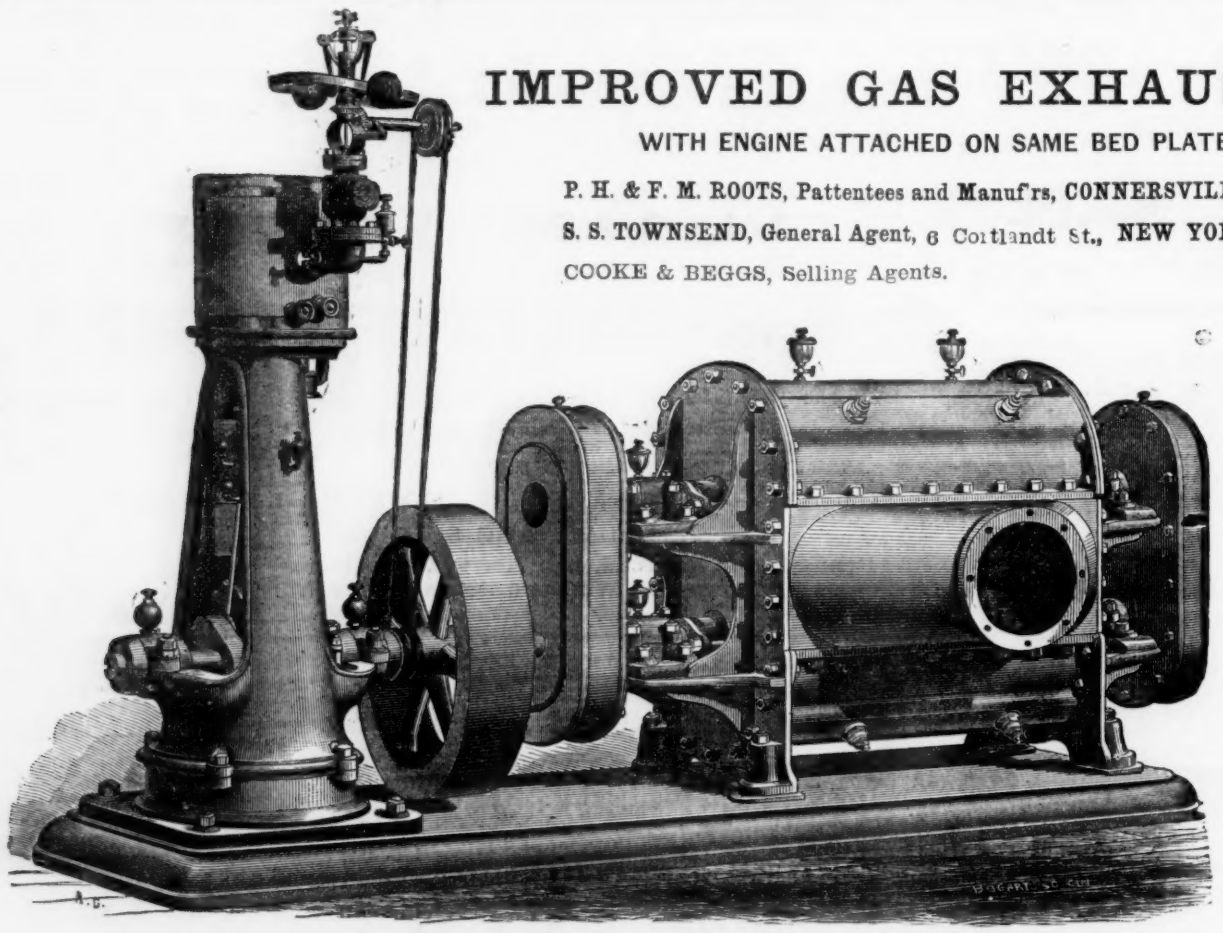

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ADVANTAGES CLAIMED FOR THIS EXHAUSTER.

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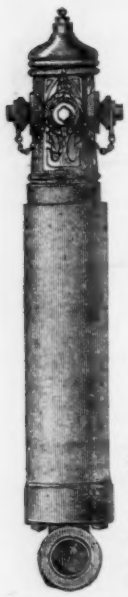

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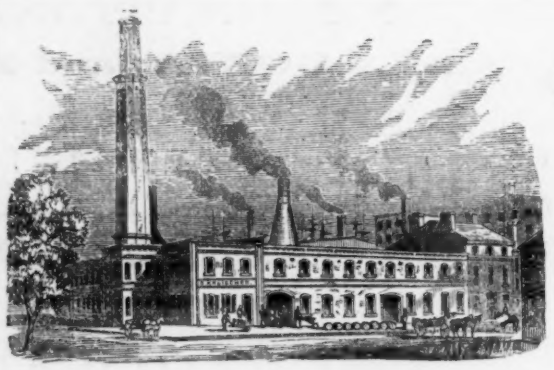

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PATENTED MAY 23rd, 1876.

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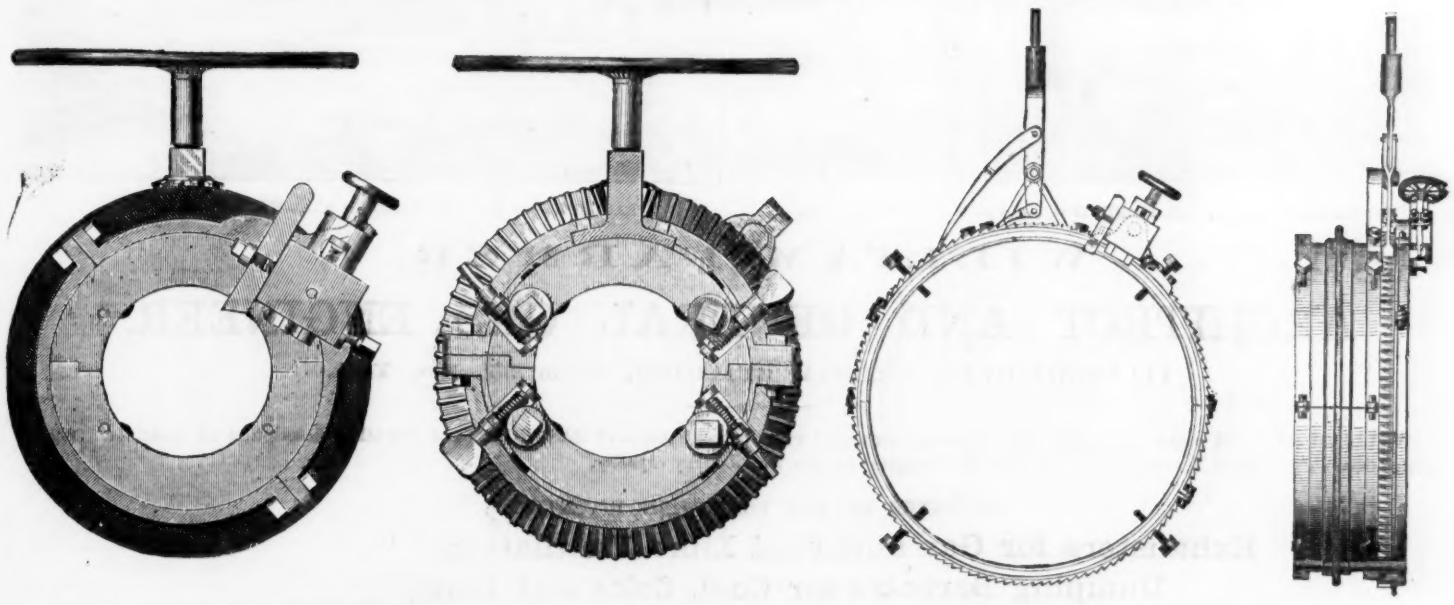

It will cut Cast or Wrought Iron Pipe, Shafts, or Columns of any size, making a clean, smooth, and square cut. Also,

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Retort Settings,
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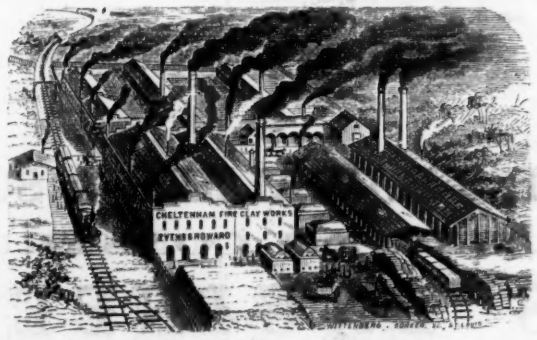

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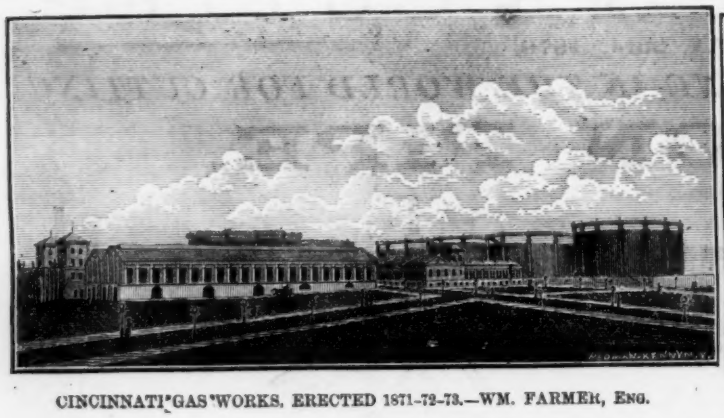
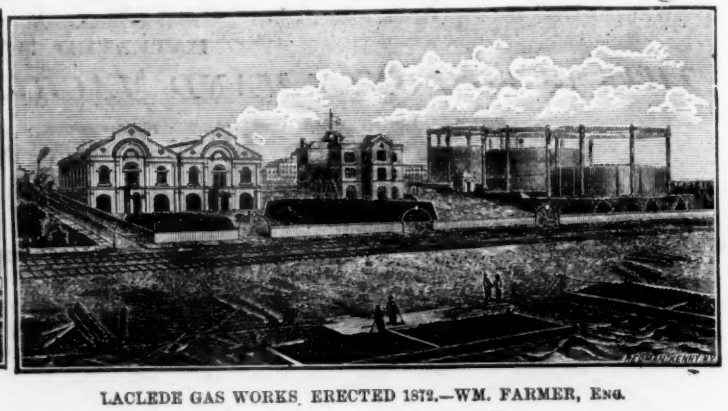


CINCINNATI GAS WORKS, ERECTED 1871-72-73.—WM. FARMER, ENG.



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Exhausters for Gas and Foul Lime Ventilation,
Dumping Barrows for Coal, Coke and Lime,
Hydraulic Mains for Retort Benches,
Blowers for Forges, Foundries, &c.
Pumps for Water, &c., &c.

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A. W. BENSON, President Brooklyn Gas-Light Company, Brooklyn, N. Y.
W. W. SCARBOROUGH, President Cincinnati Gas-Light Company, Cincinnati, Ohio.
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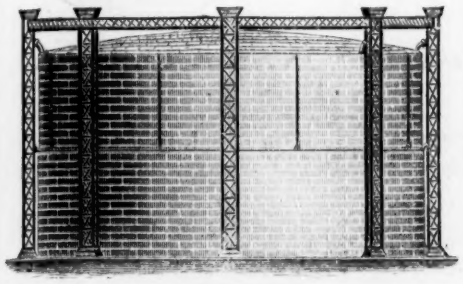

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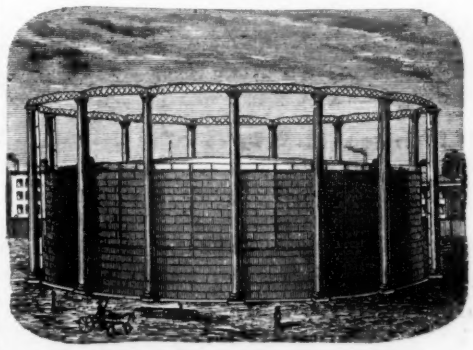

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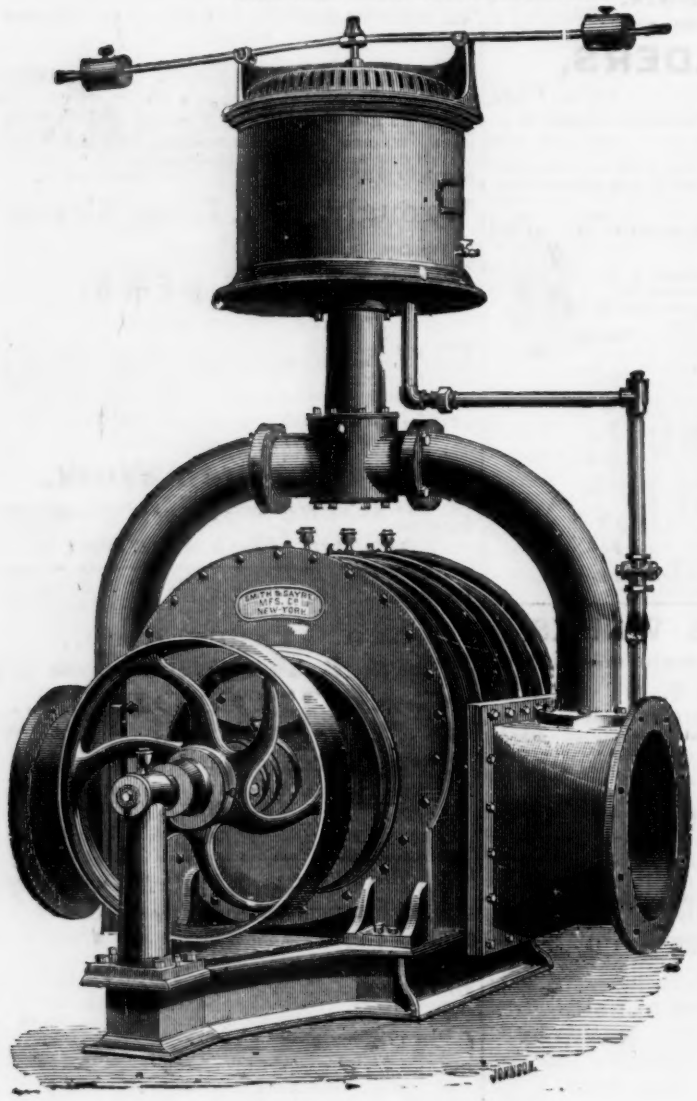

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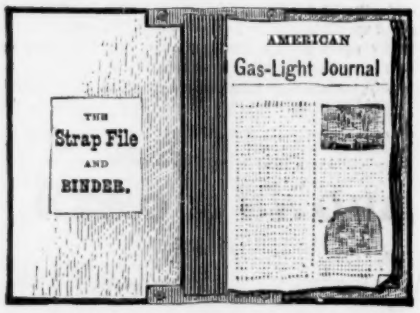

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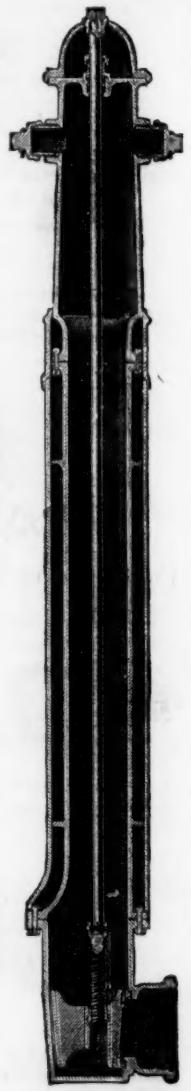

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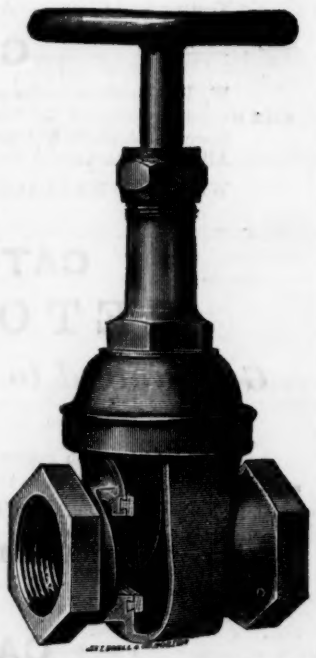

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